Department of Agriculture and Commerce,
N.-W. Provinces and Oudh.

IN THE

NORTH-WEST PROVINCES.

PAPERS

RELATING TO THE

CONSTRUCTION OF WELLS FOR IRRIGATION

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REPORT

ON

WELL IRRIGATION IN THE NORTH-WEST PROVINCES AND OUDH

BY

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FROM

CAPTAIN J CLIBBORN, B S C,

Executive Engineer

To

THE DIRECTOR, DEPT AGRI AND COMMERCE,

NORTH-WESTERN PROVINCES AND OUDH

Dated Naini Tal, 15th August, 1882.

SIR,

I HAVE the honor to forward a Report on Irrigation from Wells as practised in these Provinces in compliance with your demi-official instructions

You will notice that the results I have arrived at, if correct, show that well irrigation is only profitable under favorable conditions, and there is reason to believe, that in most districts cultivators have already very fully availed themselves of their opportunities, leaving to us now only the doubtful sites to occupy, if we enter in an extended scheme

There are, however, many opportunities for profitable Government interference in detached situations, and above all in the repair of existing works, to the financial success of which, however, the increase in cost due to the supervising establishment will prove a serious hindrance

Of all the districts I visited, Bulandshahr presents the most favorable conditions for well enterprise, but detailed enquiry is necessary I will forward the statistics of the worst villages in the pergannas noted in a few days

I had intended putting up a series of subsoil water contours with this Report, from which some hints on the causes of the variation in quantity of supply might be expected, but I regret that all the necessary information has not as yet arrived

I trust to be able to forward them to you in the course of a month

The recent advances in electricity may prove an unexpected means of famine protection in these Provinces, and the water power of the canal falls could not be better employed, than in lifting water, either from the rivers, for those tracts where wells are impossible, or from wells with a good supply

From the Note on the Moradabad Wells, it must not be supposed that it is impossible to build wells giving a good supply in pure sand, it is only a matter of expense, if the well rested on a platform of concrete of thickness and area sufficient to support it over the inevitable hollow in the sand below, we would have an admirable imitation of the mota, which should be perfectly successful, the cost, however, of laying such a platform, say 20 feet below water surface, would be considerable, and the necessary area is yet a matter of theory

I have the honor to be,

SIR,

Your obedient Servant,

JOHN CLIBBORN, CAPT, B S C,

Executive Engineer

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INTRODUCTION

The importance of well irrigation.

1. Irrigation from wells has been practised in these Provinces from time immemorial. The subject is one in which Government takes great interest, and justly so, as the area watered is large, and such irrigation in many districts constitutes the only means of bringing a high class crop to maturity

Increase desirable.

2 There are vast inequalities in the distribution of well irrigation, even in districts in which there is an equal demand for water, and the question which naturally suggests itself to all interested in agricultural improvements is, why not increase the number of wells until districts requiring water have a full command of it?

Information necessary.

3 To answer the above satisfactorily, it is necessary to investigate the following points —

1st The available supply of water.
2nd „ „ labor
3rd The cost of irrigation.
4th The area commanded per unit.

The unit selected

4 The necessity for information on the first three points is self-evident—it is important to know the fourth, as without it we cannot determine the number of wells required for a given area And it may be here explained that the unit selected is one pair of cattle or men employed actually lifting water

Cost variable

5 The cost of irrigating a given area depends on a number of factors—such as depth to water surface, amount and kind of labor employed, situation and crop For instance, wheat in Muttra requires five waterings, in Moradabad only one, gram is rarely watered more than once, while tobacco often takes ten waterings, and the depth of water given to different crops also varies greatly

Existing statistics useless

6 Abundant statistics regarding well irrigation exist, but unfortunately they are of little value in the present instance, as the area irrigated has nearly always been returned per well, and a well is not invariably one unit, but often contains as many as 8, indeed there are instances of wells containing 16 to 20 units

Ditto ditto.

7 In many examples on which calculations have been founded, irrigable areas were returned as irrigated, and wells which failed to give any useful supply in ordinary years were counted on as capable of a high duty in famine time

Former experiments insufficient,

8 Again with reference to the quantity of water lifted per day, the experiments have usually been carried on for a short period only, and the day's work calculated by multiplying the result by an assumed number of hours representing the day's work.

and misleading.

9 This method is inaccurate and misleading, for the rate of work on every well, as might naturally be supposed, varies greatly during the day, with the condition of the cattle, the men, and the depth of water It is always dangerous to calculate large results from small percentages, nor is it unlikely that the Assami will be interested in the result, and attempt deception, which need only be carried on for a short time, and will not seriously interfere with his day's work

Experiments how made.

10 For the above-mentioned reasons, I determined that the only way to arrive at a just conclusion on the subject of well irrigation was to experiment for the full working day on all classes of wells over a large area, and also to record, personally, as far as possible actual areas irrigated, number of times each crop is watered, and all other details bearing on the subject

Scope of observations.

11. The Report now submitted gives the result of these experiments, which were carried out in 20 districts of the North-Western Provinces and Oudh, over a distance of 1,200 miles, at intervals averaging 10 miles apart, the line of country covered is shown on *Plate* IX., and it will be seen that it embraces every class of well irrigation, from the first class Kili lifts of Aligarh to the percolation wells of Bundelkhand, and the Dhenkli irrigation of the semi-Terai tracts *

* *Vide* Table A.

THE SUPPLY OF WATER AVAILABLE FOR IRRIGATION FROM WELLS

The water bearing strata

12 The sub-soil water supply in the Gogra-Ganges Doáb is, as far as is known, inexhaustible, and nearly everywhere it is at a reasonable distance from the ground surface, but irrigation decreases in a marked manner when the depth to water surface exceeds 60 feet. The water-bearing stratum as a rule is sand, which in most instances is overlaid at varying distances from the ground surface by a bed of clay, indurated sand, or kunkur, called variously "mota," "matbarowa," or "nagasan"

Indurated sand and kunkur beds local.

13 The existence of the indurated sand and kunkur beds is obviously due to local action since the Doáb was first formed, they are met with in but a few isolated localities, and have little bearing on the general question

The mota.

14 Far different is the case with the clay bed or mota Where it occurs, wells are always possible, and there are few Zemindars or Assamies in any village who cannot point out with accuracy the site and depth of the layer

When deposited.

15 The mota was deposited at the period of the formation of the Doáb, and in conjunction with the sand strata, was probably the result of action similar to that which now produces clay beds in the khadirs of deltaic rivers

Not universal

16 The mota is not universal, its general distribution is shown in *Plate* III., and there are only a few isolated villages even in the best districts in which it is found everywhere

General distribution

17 Referring to *Plate* III, it will be noticed that the mota is not known at all in those tracts directly underlying the hills, and gradually increases in occurrence as the slope of country decreases, it is, however, much more prevalent in the Ganges-Jumna Doáb than in the Ganges-Gogra Doáb

All clay not mota.

18 The term mota is not applied to all clay strata, but only to those either underlying or directly overlying sand containing water, there are often many such strata of varying thickness and at different depths

Situation known to cultivators

19 Canals are only a recent introduction compared with wells, which in many districts have been the only means of raising high class crops for a naturally stable community The accurate knowledge which villagers generally possess of the position of the mota is not, therefore, to be wondered at It is not universal as might be supposed, but when a cultivator asserts his knowledge it may generally be accepted

from experience

20 Their information is of course derived from experience gained in excavating for wells, which have either proved failures, or have been filled up or broken long since In many cases the memory of the former well has been lost, and I have come across several instances in which new wells have struck on old and long forgotten ones, the sites having been chosen on a tradition of the existence of the mota

It is curious to note that although the mota may be scarce in a village, if it exists at all the inhabited site will be found on or near it, so placed for obvious reasons, and perhaps the mota may have had more influence on the selection of the sites for great native towns than it is generally given credit for Amroha and Bareilly may be instanced

Sub soil sections.

21 Sections A to G (*Fig* 1, *Plate* I.) illustrate various conditions of sub-soil found in the Doáb, they might be indefinitely multiplied, as the clay, sand and water occupy every possible relative position

Spring wells.

22 Leaving out of the question for the present wells which receive a supply from percolation, we will consider the case of what are usually termed spring ("Bom") wells, which should be sunk so as to have the curb or lower ring firmly embedded in the mota, thereby (if a masonry well) shutting out from direct entry all water overlying it Now the generally accepted theory regarding the use of the mota for water supply is that it acts as an artesian basin, and that the supply entering the well through an orifice which is bored in the clay is a veritable spring,* caused by the pressure of water from the collecting area of the basin

* Such wells are termed spring in the Tables to distinguish them from percolation wells

Artesian action unlikely

23 The facts which are alleged to support this theory are *first*, that until the mota is reached the water supply is easily exhausted This is contradicted by experience *Secondly*, that when the hole is bored into the mota a copious supply of water enters the well, often causing danger to the workmen if they do not escape quickly, and sometimes rising above the mouth But the artesian theory pre-supposes the comparative continuity of the mota, which is at variance with the universal testimony of cultivators, and the facts alleged are easily explained on other grounds, *vide* paras 26–30 It will also be shown that artesian action is quite incompatible with the strata of the Doab

Sub-soil water contours desirable

24 Although the ground surface of these Provinces has been thoroughly surveyed, and numerous cross sections taken of the ground levels, unfortunately there has been but little systematic attempt to contour the sub-soil water surface, for which, in conjunction with the ground surface levels, we possess unrivalled facilities in the numerous wells, and it is certainly desirable that in future surveys the sub-soil water and the position of the mota should be measured and recorded in a similar manner to the ground surface

The curve usually shown by a Doáb Cross Section.

25 *Plate* IV shows the sub-soil water and ground surfaces on a section taken across the Deoband Doáb along the Shamli road, and may be taken as a type The water surface is at its highest in the centre of the Doáb, and gradually falls in a rapidly increasing slope as it nears the rivers on both sides The longitudinal slope is one corresponding in some degree to that of the country, and over the whole area in which the so-called spring wells exist, it does not exceed 1 to 2 feet per mile There is abundant evidence that the water from the high land drains into the rivers on each side at a slope of about 1 in 100, or 50 feet per mile, (it varies according to the nature of the stratum,) and even if the mota were uniformly continuous and regularly overlaid the water-bearing strata, (which it does not,) it is evident that there could be very slight, if any, artesian action A type section of the mota as it really occurs is shown in *Fig* 2, *Plate* I

*Mr. Beresford's theory of supply

26 The following theory, advanced by Mr J S Beresford, Executive Engineer, Irrigation Department, appears to offer a true solution of the action which takes place

It is admitted that in new wells when the hole through the mota is first made, a certain quantity of sand is forced up into the well with the water, but after a short time this emission of sand ceases, and if the mota is a good one (3 to 5 feet thick of hard clay) no sinking of the well takes place A hollow in the sand beneath must, therefore, be formed, and Mr Beresford assumes that it is of the form (C) shown in *Fig* 3, *Plate* I, and that the mota merely acts as a platform to support the well over this hollow in the sand, which gives a surface large enough to discharge a supply corresponding to the head given

The "Head"

27 The head is the difference of level between the water inside and outside the well, for when water is drawn from a well the surface reduces more or less rapidly according to the quantity drawn out and the strength of the supply, and at length a point is reached when the water vacuum is just sufficient to draw in a supply equal to the quantity taken out This is the mean head, it naturally varies a good deal over the Doáb, and can be found for any of the experimental wells by deducting the figures in column 67 from those in column 66, Table A.

Artificial imitation of the mota.

28 This theory is well supported by facts familiar to Engineers experienced in laying foundations below water surface on sand, where these consist of a platform resembling the mota If any flaws exist, after a slight primary emission of sand, nothing but clear water is discharged, and no damage to the foundation occurs, provided the platform is thick and strong enough to act as a beam over the hollow in the sand below The size of the hollow will be modified by two conditions —

1 The head, which regulates the quantity of discharge
2 The comparative fineness of the sand, which regulates the rate of discharge

The coarser the sand the smaller will be the hollow Perhaps the best idea of the area required to admit of the delivery of a given quantity of water in a given time may be obtained if we represent the spaces between the particles of sand by the holes in fine wire gauze of varying gauges Coarse netting will require a smaller area to admit of a given discharge than fine netting

Action of land springs.

29 Similar action may be observed by any one curious enough to examine the *true springs* when the sub-soil water escapes at the junction of the bangar and khadir On the

* *Vide* Appendix I.

banks of our large rivers the khadir from A to D will usually be covered with a clay deposit over sand, and the springs burst out at A, *Fig* 4, *Plate* I, and flow into swamps between A and D, or to the river direct A sort of cup or hollow is formed, *see* B, in which the sand bubbles up with the force of the spring, but when the area of the surface of the hollow is large enough to discharge the water supply, nothing but the very finest sand is carried away

Result of drawing water from a well resting on fine sand.

30 If a well rests on sand alone when water is drawn, abstraction of sand takes place from below, and the well being a heavy body sinks into the hollow The effect of drawing water from a well in pure sand is to drain an inverted cone, the height of which is represented by the depth of the well below water surface, the steepness of the sides varying directly with the fineness of the sand stratum, *Fig* 5, *Plate* I

It will be seen that the content of the cone increases with the depth of the well below the percolation level

The water nearest the well is first drawn into it, and passing vertically down close outside, draws the sand with it into the well, and if the process is continued long enough, the sand will eventually rise into the well until nearly level with the water outside *

Wells possible in very coarse sand or gravel.

31 The results described will only occur when the quantity of water drawn from a well is greater than the surface exposed, *i e*, the area of the bottom of well can deliver There are wells on the margins of the Bundelkhand lakes which give an ample supply from fine gravel, and which correspond in every point with the example above described, except that the intervals between the particles are greater

Wells in fine sand possible but expensive.

32 There is no difficulty in designing a well which would work successfully in pure sand of any fineness, it is only necessary to make it large enough, but the expense in the strata usually met with in the Doâb would be enormous, and as far as practical irrigation is concerned it is out of the question

Wells resting on pure sand are constantly used for drinking purposes without any injury to their stability

Advantage of the resistance sand offers to flow of water

33 For the *ordinary cylinder* well it is therefore evident that the *existence of the mota is a necessity for its success*† as an irrigating medium, and it is worth noting that but for this very resistance which sand offers to the passage of water, irrigation wells would practically be impossible in the Doab, for the sub-soil supply would drain away to the lowest point, its contour would be a nearly level line between great rivers, and the depth to water on the watershed, which is now the least at the tablelands, would be a maximum.

Variation in quantity of supply

34 There are great variations in the quantity of water capable of being drawn from wells close together and apparently similar in all respects, but the explanation is simple enough when we remember that the area of the mota must have a similar effect to an increase in the depth of the well in enlarging the diameter, and consequently the content of the drainage area (*vide Fig* 6, *Plate* I)

Percolation wells when used.

35 Percolation wells are used under the following conditions —

(*a*) When the mota does not exist

(*b*) When it does exist but is at such a depth below water surface that it is too expensive or too difficult for the people, with their existing means to reach it.

(*c*) When wells resting on the mota become injured from various causes

(*d*) When they pay better than mota wells Water enters a percolation well by filtration from the sand, either through crevices in the wall of the well, or through a grass or twig lining, which admits the water while holding the sand back. Such wells are generally found in the khadirs and low-lying lands, where recent diluvial action has washed away the former strata, replacing them by nearly pure sand On the outskirts of the town of Jalalpur, (Shahjahanpur District,) there is a curious instance of this action For miles round, the Ramganga, which is a great wanderer,

* *Vide* Moradabad well experiment.

† Natural or artificial.

has cut away the old strata and the mota is unknown, except where a kunkur stratum exists in a small patch of 16 acres in extent, which is crowded with no less than 14 kucha wells, some of them 100 years old —all worked with Rátis, a class of lift not much used elsewhere in the pargana Percolation wells are also extensively scattered over the districts lying under the hills, where, as before noted, the mota is rarely found, and as (in common with the khadir) such lands require little water compared with the more southern districts, there appears to exist a sort of balance of power regarding the facilities for irrigation in the various tracts of the Doáb

With reference to the four conditions under which percolation wells are used, *Case* (*a*) is self-evident, *Case* (*d*) will be dealt with when the cost of irrigation is considered

Case (*b*) occurs—

1st In villages, most parts of which possess a good mota easily obtainable, but certain other areas have the mota either at a greater depth or overlaid with quick sand, and the people, accustomed as a rule to dig wells with facility, magnify to themselves the difficulties to be met with in these isolated areas, which, in less favored villages, would be considered serviceable

2nd When the mota is at such a depth that the Capital outlay would leave no margin for profit

3rd In areas where the mota is overlaid with sand formerly dry, in which kucha "Bom" wells were the rule, but where now, from a rise in water level, the sand has become saturated, and the people are unable to reach the mota simply because they cannot dig through the wet sand In the 1st and 3rd cases the advantage of Government interference is obvious, advice and regulated advances would be invaluable

Case (*c*) occurs—

1st When the mota is thin If the well is overworked the supply of water will increase, but so will the hollow under the clay, and eventually becoming too large for the thickness of the mota, the well drops through and is practically ruined This occurs frequently in *famine years*, when good wells are strained to the utmost Fortunately there is often a second layer some distance below, and were advice and assistance afforded, many pitiable examples of wasted capital could again be made profitable

Cultivators are frequently well aware of this danger, and will refuse to allow a second *churrus* to be used, although apparently the supply in the well is ample

2nd When the well gets broken below, and the owner is afraid to clear it out and re-open the mota. These cases are quite remediable in most instances, but often are beyond the powers of the owners

3rd When through carelessness the well is allowed to get filled with debris and a small supply only filters through This is scarcely a case of enforced percolation, and occurs mostly in those canal-irrigated villages, when the water surface has been so much raised that such a well will suffice for the irrigation of a small plot of opium or garden produce * In cases like this it would appear advantageous to reserve the canal supply for less favored localities

4th When the sub-soil water falls below the mota This does not invariably result in the well becoming percolation. Often as before mentioned a second mota exists, and if it can be reached the well may be underpinned, and a fresh supply obtained from the lower layer, for its stability is in no way endangered as it rests on the mota above If, however, no lower mota exists, or if it is at a great distance, the cultivator can only dig a hole in the sand below, line it with grass and obtain a small and intermittent supply, the end is generally the destruction of the well, as the mota is gradu-

* Cultivators in canal villages often keep up a sort of home farm round the well to employ their cattle on, and opium is a favorite crop, as it requires frequent and thin waterings.

ally undermined, from the abstraction of the sand by the bucket, and it has also lost the support given by the water formerly below it

Sources of supply

36 It is somewhat difficult to understand how the rain water, which naturally must be the main source of the sub-soil supply, finds its way below the surface Experiments made after heavy falls on plateaus show that the depth to which water penetrates directly into tho soil is not great, it varies from a few inches to as many feet according to the nature and level of the surface, and from the sub-soil water contours we see that the rivers even in heavy flood can have little or no effect.* Practically what we want to determine is the source of the supply in the higher levels, *i e*, AA of any Doah cross section, *Fig* 7, as these must be nearest the source, the lower levels clearly being the result of slow drainage towards the rivers on either side That this drainage is very slow is both certain and fortunate, certain, because we know that the level in wells even in years of excessive drought falls a few feet only compared with the great difference of level which exists between the surface of the water at the centre and the edges of the Doáb, for instance, in the section of the Deohand Doáh hefore referred to, the difference of level is 16 feet in a distance of $1\frac{1}{2}$ miles, which is a comparatively flat slope, but we have no record of any fall in wells near this approaching 16 feet The resistance to drainage is fortunate, as without it the contour would assume the direction of the dotted line CC, (*Fig* 7, *Plate* I,) which in many districts would he fatal to the interests of well irrigation That the rainfall does not filter evenly down from tho wholo surface exposed may be accepted as evident, but there are great variations in the nature of soils, and any cursory inspection of a map will show the watershed intersected with jhils and hollows, the majority of which undoubtedly have clay beds, but in many tho soil is more or less porous

Sources local

37 This assumption of local and isolated filter beds is supported by the fact that the rise of water in wells is most marked in some villages, while there is scarcely any yearly variation in others, and in all the water usually resumes its normal level by the end of the cold weather

Bhognipur wells

38 A good example of the effect of the water in tanks on wells is found in the Bhognipur village, Cawnpore District, the plan of which (*Plate* VII.) shows a marked variation in depth according to tho positions of the wells with reference to the various village tanks

Normal level

39 It has been noted that the sub-soil water will practically stand at a slope of 1 in 100, but it must he remembered that this is when it has an outlet, even though the quantity discharged may he small, if no escape is possible and the supply is cut off, the surface must assume a much flatter slope in time

Water surface high in sandy tracts.

40 Accepting this theory of local sources of supply, wo ought to find a high surface level in sandy tracts indifferently supplied with the mota, and the Hasanpur pargana of the Moradabad District is a good example, as there the water level is found at 10 to 15 feet from the surface

Supply from hill rainfall small.

41 The rivers taking their rise from springs near the hills and the Terai streams carry off a fair share of the rainfall which has been absorbed by the hills The nearer tracts may be partly fed by the hill rainfall, but it is difficult to imagino the great length of the Doáb to be supplied from such a source, it indeed appears impossible, when we remember the way in which the Doab is cut up by deep streams often heading the drainage

Enquiry into local sources needed.

42 The Doáb rainfall must, therefore, be credited with the natural supply of sub-soil water above the mean level of streams, and an enquiry is much to be desired into the local sources of supply, tho amount of water held in suspension, and the curves which it assumes under different conditions

Artificial sources of supply

43 The artificial supply is obtained mainly from canals, it is, however, local Permanent sections of the canal are rapidly silt-lined, which forms a good watertight medium, and great attention has for some years been given to fixing gradients which will avoid either erosion or heavy deposits When percolation occurs, the distance is limited by the abrupt slope which the water assumes, and the amount by the fact that canals are usually carried along tho watershed where the sub soil surface is highest, *see Fig* 8, *Plate* I and *Plates* V and VI

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* In tho Deohand Doab the sub-soil contour is 5 feet higher in the centre than the maximum flood level in the rivers on either side, and higher up every Doáb the excess is much greater

The Agra Canal.

44 The Agra Canal affords a good example of this action, the water surface has been raised in a gradually decreasing amount as the distance from the canal increases, and at an average distance of half a mile the influence is unfelt.

The local supply from Canals compared with rainfall small

45 That the influence of the canal in raising sub-soil level is small compared with rainfall is well shown by a section, *Plate* VI, prepared by Mr W Willcocks, Executive Engineer, in 1879, which was a year of excessive rainfall, while 1877, also shown, was a year of drought, in which the canal was constantly run with a full supply The section was taken along the Meerut and Ghaziabad road, which runs nearly parallel to the canal and drainage lines, and is therefore no guide, unfortunately, to the transverse slope of the sub-soil water surface

Swamps how formed

46 Swamps are formed by percolation from canals when the level of the ground surface intercepts the line of water slope, and also when the slope is flattened by an intercepting bed of clay, in both instances puddling the bed would be a more efficient remedy than drainage, which increases the quantity of the water percolated, *Fig* 9, *Plate* I.

Abnormal fall in water surface a great injury to masonry wells.

47 Drought, as might be expected, has a marked influence on the sub-soil water level in tracts of extended well irrigation when there is no artificial supply

In some parts of the Muttra District the fall in water surface amounts to from 15 to 16 feet during the last five years, and it has injured a number of wells, as in some instances the water has fallen below the mota

There is a possibility that the marked and, as far as irrigation wells are concerned, destructive fall of water surface in the Muttra District, has been partially caused by over drainage in the Aligarh District A glance at the Map will show that the parts of the Aligarh District which have been most effectually drained, were probably the local collecting areas which kept up the sub-soil surface in the tracts now suffering in Muttra, where there are comparatively few jhils, and the fall occurred just about the period at which the drainage system was perfected

A satisfactory explanation of this, and other interesting matters relating to the sub-soil supply, can only be obtained by carefully observed sub-soil water contours, and the subject of a complete Map of the North-West and Oudh water levels has been brought to the notice of Col Forbes, the Chief Engineer for Irrigation, and has received his approval as far as the preliminary arrangements are concerned

How repaired in Muttra.

48 The Assamies have repaired some wells in an ingenious manner by underpinning the masonry with a wooden or a grass lining An interesting example of this is No 6618, village Bheema, pargana Mahaban, *Fig* 10, *Plate* I

Two-lift well, old Water surface has fallen 12 feet during last 5 years For 4 years the well was kept at work with a grass lining, last year a wooden lining was put in This well cost Rs 400, and though built with lime, is now showing signs of giving way The present supply is percolating through the sides of wooden lining or *lothi*

Where most observable

49 The following accounts of the abnormal permanent fall of sub-soil water level were supplied by Assamis in the field, and in all cases the fall had caused injury to the wells—

District.	Pargana.	Village	Fall in feet.
Aligarh,	Hathras,	Sasni,	6
,,	,,	Hathras,	4
,,	Iglas,	Iglas,	6 to 8
Muttra,	Saadabad,	Munsia,	6
,,	Mahaban,	Mirhouli,	a few feet.
,,	,,	Raya,	15
Shahjahanpur,	Pawaine,	Dharmangatpur,	5
Unao,	Unao,	Unao,	a few feet

Bundelkhand supply

50 In Bundelkhand the sub-soil is not uniform as in the Doáb, the mota is unknown, and supply varies greatly according to locality, both in quantity and depth below the surface of the ground

Soils.

51 The soils of Bundelkhand and their characteristics are well known, they consist of "mar," "kabar," "parwa," and "rakar" Mar usually overliesthe parwa and rakar, the exposure of the surface of which is supposed to be the result of denudation In the more northern tracts of Hamirpur the direct rainfall appears to be the source of the sub-soil water supply, which has a better chance of filtering down than in the Doáb, owing to the undulating nature of the country

No mota.

52 The absence of the mota overlying sand charged with water, deprives Hamirpur of the ample supply generally obtainable in the Doáb But there are local spots where a very good supply is obtainable, and nearly all the large villages have a fair area of garden cultivation which is irrigated

Surface level generally high on village sites.

53 The depth to water surface is usually less on the inhabited sites than in the village "har," or outlying cultivation, (*Fig* 11, *Plate* II.,) and this is explained by the fact that the villages are always from choice placed on parwa soil Mar being considered feverish, and rakar bad for cultivation Denudation of mar, of which parwa is commonly the result, would naturally take place first from the highest points of the general surface of the country, the village will, therefore, usually be on a relatively high point of the sandy or water-bearing strata, and consequently near the water

Rapid fall in water surface after the rains

54 Although after the rains and during the cold weather the supply is fairly plentiful, yet in many places by the beginning of the hot season it becomes much reduced, and wells frequently dry up This appears to be due to the coarser nature of the soil, which permits of purely percolation wells being used, *vide* para 31, but the water can also assume a much flatter slope to the drainage on either side Deep wells would appear to be the only remedy, but the point to which they should be sunk must be locally fixed, as the water falls below the beds even of the drainages in many instances

Rock wells

55 In the southern parts of Hamirpur rock wells are common, the overlying strata are soft and dry, and the wells are sunk into the solid rock, the water gradually increasing in quantity with the depth The supply is always precarious, and seems to be derived by percolation from fissures in the apparently solid rock.

Artificial supply from lakes.

56 The Bundelkhand lakes are caused by obstructions placed across the natural drainage outlets, where the slope and conformation of the country is suitable for the formation of reservoirs Direct irrigation is practised from many of them, but is precarious, being dependent on the previous rainfall Nor is it practised with that economy which the known limitation of the supply and the cost of artificially raising it should enforce

The beds of those lakes are porous, often owing to the proximity of the hills, much mixed with gravel, and the supply spreads freely through the strata surrounding the lake, and it is here we find the best well irrigation in Bundelkhand Even when the lakes dry there often remains hidden under the surface a copious supply which is distributed by the cultivators on the most economical principles

Owing to the short depths to water surface and the coarse nature of the soil, wells can be cheaply built, and the cost of lifting is small.

Canals from lakes not economical.

57 The question of entirely stopping direct irrigation from these lakes is certainly worthy of consideration The area capable of being irrigated would *certainly* be much increased from the enforced economy, and it is probable that the sub-soil supply would outlast even two years of drought if the lakes were not reduced by directly drawing water from them

Increase in number of lakes desirable.

58 Even small lakes scattered over the country would be of the greatest benefit, and the capital saved by the omission of the canals might be devoted to the assistance of the Zemindars in building wells, on which a rate could be charged sufficient to cover the outlay

VARIOUS METHODS OF LIFTING WATER

Cattle lifts.

59 In the Districts examined, except in a few isolated instances, cattle are only employed on what are called the "Kili" and "Lagor" systems, in both of which the *churrus*, or leather bag, is drawn up filled with water by a strong rope fastened to a wood or iron ring, round which the edge of the *churrus* is tied, the rope is carried over a pulley fixed on a framework overhanging the well mouth, and the cattle travel up and down an earthen ramp, sloped at an angle varying from 5 to 20 degrees The *churrus*, or *pur*, as it is often called, when emptied by a man standing at the mouth of the well is again lowered down into the water and refilled.

Lagor

60 When working Lagor there is only one ramp or slope, and when the *pur* is emptied the bullocks turn round and walk up the slope with the rope still attached to the yoke

Kili

61 The term Kili is derived from *kil*, a nail or peg of wood, and when cattle are worked in this system, as soon as the *pur* is empty the driver takes out the peg which fastens the rope to the yoke, and holding the end of the rope in his hands, allows the weight of the *pur* to draw him up the ramp A (*see Fig* 12, *Plate* II) The bullocks walk up a second parallel ramp B, to a feeding trough C, fixed near the top of the working ramp, and as soon as the *pur* is re-filled are again ready for work

Advantages of Kili.

62 The advantages of Kili working over Lagor are that it does not harass the bullocks, it is easier on the driver, and it enables a number of cattle to be used at the same time, thereby saving delay and expense Any one who has observed cattle worked Lagor will be well aware of the irritation caused by the jerks their necks get when the empty *pur* is thrown back into the well, nor do they get any food when working It is easier on the driver, as he gets pulled up the ramp, and it saves time and expense, since two to four pairs of cattle can be employed at the same time, each pair waiting their turn When the cattle are well trained only one driver is necessary, as the food near the well attracts them The driver goes up the ramp much quicker than cattle do, and therefore more work is done in the time, one pair being always ready to lift In both systems the driver usually sits on the rope going down

Distribution of Kili and Lagor

63 The distribution of the Kili and Lagor systems is shown in *Plate* VIII , it is curious that it should be so local, but except on the boundaries, the systems are absolutely un-mixed, and this although the great advantages of Kili working are admitted by most cultivators who know it.

Content of lifts.

64 The capacities of the various lifts are given in Table F , and it is interesting to note the difference in content Lagor lifts vary from 1 50 cubic feet in Hamirpur to 5 70 cubic feet in Farukhabad, and Kili from 2 70 in Bijnor to 7 65 in Muttra The latter weighs, filled with water, no less than 500 lbs , and requires very powerful cattle

No of units employed.

65 At Kili wells the same cattle are employed throughout the working day, but at Lagor, when more than one pair is used, the change is made at noon, and it is rare to find more than two pairs used At Kili, however, three pairs are not uncommon, and for sugar cultivation four pairs are often used, the reason of this is that the cattle are employed crushing sugarcane up to the last day to which the Assami's can put off getting in their sugar, when all combine to water the area, which is never large compared with the rabi irrigation

Minor economies

66 Besides the main divisions into Kili and Lagor, there are many minor differences in the manner in which wells are worked, some of which have a considerable bearing on the expenses

In a single *pur* well with one pair of cattle three persons are employed—one driving, one emptying the *pur*, and one in the field adjusting the depth of the supply and clearing the

water-courses In cases when an Assami's family work with him, his wife empties the *pur* and one of the children attends to the fields

When two lifts in the same well are used there is at once an economy, for it only requires at most two persons more, and so on for any number of lifts added, as one man is quite sufficient to attend in the fields to more water than any well could supply

But various other economies can be practised If the ramps are parallel and the pulleys on the same side of the well, one man can empty two *purs*, or one man can drive two pairs of cattle even at Lagor, but these unfortunately cannot be practised together, as there would be a loss of time in emptying if the lifts came up together

For two lifts on the same side a large well is required, and we therefore usually see this system employed in four *pur* masonry or in good kucha wells

The following table shows the number of persons required to work different classes of wells under the best conditions —

No of Lifts.	One *pur*				Two *pur*				Three *pur*				Four *pur*				Six *pur*				Eight *pur*			
Pairs of cattle per *pur*	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Kili,	3	3	3	3	5	5	5	5	7	7	7	7	7	7	7	7	10	10	10	10	13	13	13	13
Lagor, .	3	3		5	5	5			7	7			7	7			10	10			13	13		

Advantage of large wells.

67 The economy of large wells and Kili *in this respect* is manifest, for the eight *pur* well with four pairs to each *pur* should be equal to 32 one *pur* wells, which would require 96 men, but as will be shown further on when the number of pairs on one *pur* is unduly increased their efficiency is diminished

Well fittings

68 The fittings of wells are very simple, they vary much, however, in different districts The two main types are shown in *Fig* 13, *Plate* II. A is used mainly for kucha and B for masonry wells

Their cost.

69. These fittings rarely cost any actual cash The wood is generally the cultivator's own, and the making and repair is included in his general contract with the village carpenter What he has really to pay for are the pulley, the material for rope, which is itself home made, and the *churrus* or *pur* with its ring

The cost of the fittings and lifts for each well is given in Table A, columns 44, 47, they are of necessity in a few cases approximate, but as a rule have been placed at the lowest possible figure, and represent as nearly as can be actual outlay

The cost of the pulley and ring is included in capital, but the *pur* and rope are renewed yearly in fully worked wells The cost varies as follows —

Churrus or *pur*,	Rs 3 to Rs 9	according to size	
Ring for *churrus*,	As 2 to „ 1-4	„	to size and material
Rope „	„ 8 to „ 2	„	length and quality
Wheel „	„ 2 to „ 3	„	quality

Cattle and cost of food.

70 The value of the cattle employed varies from Rs. 10 to Rs 60 per head, and their quality has an important influence on the quantity of water drawn daily An average rate of 3 annas per pair has been charged as the cost of feeding bullocks when working, this is less than the actual cost in the case of large bullocks, and perhaps slightly more than incurred for inferior classes But good bullocks will work more days in the month than bad ones, and some small expense for food is necessary even on idle days No addition to capital has been made to cover the purchase of cattle, it is certainly doubtful whether they are ever purchased directly for irrigation, and the rate charged is intended to cover not only the food, but also the interest on share of original purchase money and depreciation

Human labor and how employed

71. Human labor is employed in four ways for lifting water in the districts examined—

1st—As cattle Lagor—drawing with a *churrus*
2nd— „ „ „ a *gurrah* or earthen pot
3rd—The "Dhenkli"
4th—The "Ráti"

Lagor with *churrus*

72 (1) is common in Lucknow, Hardui, Shahjahanpur, 10 men being employed according to the depth of the well and the size of the lift As in cattle-worked wells, one man is in the field, one emptying the *churrus*, and two-thirds of the balance pulling the rope, one-third resting

I have never seen wells worked with more than one *churrus* in this manner, the content of the lifts used is small, from 1 5 to 2 5 cubic feet, but coolies work much faster and for a longer time during the day than cattle

The cost of fitting is similar to that for Lagor wells.

Lagor with *gurrah*

73 (2) I have only seen in Unao, one to two men are used pulling on the rope, one emptying and one in the field This method is employed either when cultivators are very poor and cannot afford any more expensive arrangement, or when the supply is scanty and at a distance of 20 feet or more from the ground surface

It is most expensive, the cost of two persons in attendance being often incurred on one man drawing water Changes from one class of work to another are, however, frequently made, which somewhat increases the quantity of work done

The cost for fittings is very small

Dhenklies

74 (3) Dhenklies are well known, they are universal in the East, and consist of a lever, the short end of which is loaded so as to a little more than counterbalance the weight of the rope and empty earthen pot on the long end One man is employed lifting and emptying and one person in the field, and they change work occasionally

It will be seen that the man working the Dhenkli has to pull slightly on the rope to lower the *gurrah* into the well, but when raising he has to exert less force than the quantity of water lifted would require, and neglecting the friction on the axis, there is no loss due to dead weight if the loading is properly adjusted When the supply admits of it, two Dhenklis in one well are common, and thus the labor of one person is saved 10 to 15 Dhenklis are often seen in different wells close together lifting into a common water-course, this usually occurs when a good local supply near the surface is available, and it is a most economical system of irrigation.

The cost for fittings is small—two uprights of wood or earth are used to support the axis of the lever, which is a 20 to 30 feet pole, the length varying with the depth of the well When such long poles are not obtainable in one piece two are joined Re 1 for first cost and 8 annas for repairs during the season, will cover the expense of a single lift

The Ráti

75 (4) The Ráti or *charki* (*Fig* 14, *Plate* II) consists of a rope passing over a light pulley fixed in a framework over the well, the rope has an earthen pot attached to each end, and the man working pulls them alternately up and down As with the Dhenkli there is no loss due to dead weight lifted, and this class of lift is employed in similar circumstances, but its range is much more limited The cost for a Ráti is as follows —

Pulley,	Re 0-14-0,	lasts 5 years.
Uprights,	„ 0- 2-0	„ „ „
Rope and *gurrahs*,	„ 0- 4-0	to 0-8-0, lasts 1 year
Total	„ 1- 8-0	

Dhenklis and Rátis when used, and their economy

76 Dhenklis and Rátis are used as a rule in cases where the sub-soil consists of pure sand, or strata such as only give a small and intermittent supply, and when the depth to water surface does not exceed 20 feet

The wells in which they are used are nearly always kucha, and if lined, only with a mat or rope of grass, which just suffices to hold the sand back and to keep the cavity in the centre open enough to allow the small *gurrah* to be filled The quantity of water drawn is so

small, that the surface even in pure sand percolation wells is often not sensibly lowered, so that when the sub-soil surface is met with, at say 10 feet from the ground level, the Dhenkli continues drawing water at from 11 to 12 feet during the day This influences in a marked degree the actual cost of irrigation, and when time is not an object, it appears difficult to improve on the Dhenkli in such a situation If the supply is so bad that even the slow abstraction by the Dhenkli exhausts it, the Assami is equal to the occasion, for he halves the expense by only employing one man at the well, who alternately draws water for a short time, and then distributes it by opening the compartments in the field, thus allowing time for the supply to accumulate in the well

Rates charged for human labor

77 In calculating the cost of irrigation, the rates for the men employed have been entered in the case of hired labor at those actually paid, these vary according to the situation of the village with reference to large towns, and from other causes, such as relationship, age and class They have been obtained by careful enquiry In some cases cash payments are made, in others only food and clothes are given, the latter have been worked out at current rates Home labor has been charged at one anna per head per working day, deducting one man from the total number employed This represents the cost of food and clothes, and although it is possible for a man to live on less, yet the labor is severe, and the allowance can hardly be considered excessive

Work done.

78 Table F shows the work done with the different classes of lifts It will be seen that in the case of cattle it increases in quantity with the depth of the well, or in other words with the continuity of the labor It does not vary with men, as they can turn quickly, and in the case of cattle is reduced when the number of bullocks is unduly increased.

The gross work done by one man equals half ton lifted one foot in one minute for cattle the amount varies from a half to 3 tons per head according to quality of cattle and depth to water

The Rátı most economical.

79 The Rátı is the most efficient and economical lift for all depths up 20 feet, but men unused to it do not like the labor, and the quantity lifted is small, and it is therefore unsuitable for thirsty tracts, nor is simple coolie labor always available in quantity Cattle form the staple labor of the country, and it is therefore with reference to them that the question needs most enquiry

A continuous motion the most economical for cattle.

80 A continuous motion giving the best results, the natural conclusion is that the cattle should walk round the well, but to make the motion continuous with the ordinary intermitted lift, necessitates such a complication of fittings and ropes, that the gain is more than compensated for by the increased expense and loss of time in adjustments. The chain pump has now been brought to a high state of efficiency at the Cawnpore farm, and it is to it that we must look for the most economical distributions of water from wells in quantity

The chain pump

81. A continuous motion can be given to the chain of the pump from the bullocks walking round the well by simply lengthening and carrying it round a horizontal drum revolved directly by the bullock pole, the chain being guided by a pair of small wheels tangential to the circumference of the drum, *Fig* 15, *Plate* II

The whole arrangement would not cost more than Rs 20 over the first cost of the pump

A pump and fittings complete fit for a pair of cattle could probably be supplied from the farm for Rs 100, and the interest on this at 6 per cent. would not be equal to the yearly charge incurred by Assamis for their lifts, *viz*, Rs 8 to Rs 12

There is some uncertainty as to the maximum speed at which chain pumps may be safely worked If it is found desirable to increase the speed, the apparatus above described can be easily adapted by adding a second driving wheel, and taking off the power with a chain, *see Fig* 16, *Plate* II

THE CONSTRUCTION OF WELLS.

By cultivation advantageous.

82. The cost of wells when constructed by cultivators has been given in Table A., and the great advantages of home construction by men, so much interested in the result, and so well acquainted with local facilities, need not be further remarked on. When I mentioned the subject of well construction to zemindars and cultivators, they always expressed a wish to do the work themselves, provided the necessary advance could be had on simple terms.

Taccavi advances.

83. Their dislike to the present taccavi system must be strongly founded when the difference between the Government rate of interest and that charged for Mahajan's advances is considered; a curious instance of their dislike to taccavi on any terms occurred in Aligarh, for though the advance was offered without any interest to the cultivators of the land thrown out of canal irrigation in the Secunder Rao Tehsil, it was frequently, if not invariably, refused. The wells were built, however, and irrigation carried on, and it is possible that the absence of an advance was not much felt, as cultivators in canal villages are generally well off.

Cost of Establishment will be heavy.

84. If wells are built by Government they will have to bear the cost of the supervising establishment, which will be heavy, as the work is necessarily a good deal scattered, and small isolated works cost relatively more in this respect than large ones.

Indirect charges.

85. The following are the indirect charges which will be incurred in any extended scheme of well construction by Government agency:—

Establishment,	20 per cent. on works,	this is according to Government of India orders founded on experience.
Leave and Pension,	20 per cent. on 85 per cent. of establishment,	
Interest during construction,	at 4 per cent.	

Total cost.

86. The total of these amounts to 27·4 per cent. on works without considering the case of wells, in the construction of which exceptional difficulty is met with; it may fairly be assumed that an ordinary well to the mota, including all contingencies, can be sunk complete for Rs. 36·5 per 100 cubic feet of masonry.

This figure represents—

Actual masonry,	Rs. 25 per 100 cubic feet			
Sinking,	25 per cent. of cost of masonry			
Earthwork, ..	5	"	"	"
Curb, ..	10	"	"	"
Contingencies, ..	6	"	"	"

Cost of fittings.

87. This does not include the cost of fittings, which it is presumed the cultivator will supply himself. In the Table of relative cost, these items are separately shown to allow of a comparison with the rates worked to by the people themselves.

Estimate low.

88. The prices fixed above have been kept down to the point at which it is only possible to do the work. They will require the most careful supervision to avoid excess, and allow nothing for unexpected difficulties.

80. TABLE I —*Relative Cost of Wells if constructed by Government*

Masonry well on mots.	Depth to water surface.	Construction: Works.	Construction: Indirect.	Construction: Total	Interest at 6 per cent.	Rate per acre: Area irrigated in the year	Rate per acre: Charge per acre.	Fittings.	Annual: Lifts.	Annual: Total.	Annual charge per acre for fittings and lifts.	Total charge per acre.	Remarks.
1-Lift,	10	117	33	150	9·0	11 0	0 8	5/-	8/-	8 3	0 8	1 6	
	15	146	40	186	11·16	10 75	1 0	...	..	8 3	0 8	1 8	1-*Lift wells*—
	20	175	48	223	13 38	10 5	1 2	..	9/-	9 3	0 9	2 1	4 feet inside diameter 1 foot thickness of cylinder. 10 feet below water surface
	25	204	56	260	15 6	10 25	1 5	.	..	9 3	0 9	2 4	
	30	234	64	298	17 88	10 0	1 8	.	10/-	10 3	1·0	2 8	
	40	292	80	372	22 32	9 0	2 5	.	11/-	11 3	1 2	3 7	2-*Lift wells*—
	50	351	96	447	26 82	8 5	3 2	..	.	11 3	1 4	4 6	6 5 feet inside diameter 1 foot thickness of cylinder 12 feet below water surface.
	60	410	112	522	31 32	8 0	3 9		12/-	12 3	1 6	5 5	
2-Lift,	10	189	52	241	14 46	22·0	0 6	9/-	16/-	16 6	0 8	1 4	3-*Lift wells not economical*
	15	232	64	296	17 76	21 5	0 8	.	.	16 6	0 8	1 6	
	20	275	75	350	21 0	21 0	1 0	.	18/-	18 6	0 9	1 9	4-*Lift wells*—
	25	317	87	404	24 24	20 5	1 2	..	..	18 6	0 9	2 1	8 5 feet internal diameter 1 5 feet thickness of cylinder 15 feet below water surface.
	30	360	99	459	27 54	20 0	1 4		20/-	20 6	1 0	2 4	
	40	446	122	568	34 08	18 0	1·9	.	.	20 6	1 1	3 0	
	50	532	146	68	40 68	17 0	2 4		22/-	22 6	1 3	3 7	
	60	618	170	788	47 28	16 0	3 0			22 6	1 4	4 4	
4-Lift,	10	429	117	546	32 76	44 0	0 7	15/-	32/-	33 0	0 8	1 5	
	15	514	140	654	38 24	43 0	0 9			33 0	0 8	1 7	Lifts Kili, one unit each The areas are deduced from Muttra and Aligarh maximum-areas which are the best substantiated
	20	600	164	764	45 84	42 0	1 1	.	36/-	37 0	0·9	2 0	
	25	686	188	874	52 44	41 0	1 3			37 0	0 9	2 2	They are double the Lagor areas of Rai Bareilly, which has the highest percentage of irrigation in the Provinces, *see* Appendix IV
	30	772	212	984	59 04	40 0	1 5		40/-	41 0	1 0	2 5	
	40	943	260	1,203	72 18	36 0	2 0			41 0	1·2	3 2	
	50	1,113	307	1,420	85 2	34 0	2 5		44/-	45 0	1 3	3 8	
	60	1,284	350	1,634	98 04	32 0	3 0	.		45 0	1 4	4 4	

4 lift wells the best.

90 The uniformity of the results shown were somewhat unexpected, for there does not appear to be any great saving in one class over another, but as shown in the note on "various methods of lifting," there is a great saving in the cost of drawing water when 2 lifts are worked together at the same side of a well, the 4-lift wells are, therefore, the best as far as regards the cost of delivering water from a well. The diameters given in the table are the minimum used for the number of lifts, and are only just large enough for full sized *purs*, it would be an advantage to increase them slightly all round in practice

Increased depth of water.

91 The depths below water surface, *i e*, 10 feet for 1-lift to 15 feet for 4-lift are relatively increased, as an increased head is required to supply a number of lifts in the same well

Cost of fittings.

92 The cost of fittings has been thrown on the cultivators, it would be far better for Government to incur the increase of capital, and fix good stone uprights and platforms on each well. This cost would be repaid by the stimulus given to early irrigation, as often at first combinations are difficult, and no one Assami will care to go to the expense of fitting up a well, the benefits of which he will only partially enjoy

Cost of lifts.

93 The cost of the rope and *churrus* will of course fall on the actual irrigator

Interest charges.

94 Advances for productive Public Works are now made by the Government of India at 4 per cent, the interest on Capital has, therefore, been charged at 6 per cent, to allow for unforeseen charges, preliminary operations, settlement, &c

Dry brick wells

95 Dry brick wells have not been estimated, as where they are built, kucha wells are nearly always possible, and the lining is used merely as a means of protecting them from the wash of the bucket, a matter which should be encouraged as much as possible, but which scarcely calls for direct Government interference, as the expense is usually small Percolation dry brick wells cannot be recommended When the supply is near the surface the Dhenkli and Ráti are a much cheaper means of lifting water than a *churrus* from a surface lowered to obtain the head which is required by the latter, and when the depth to subsoil surface is great, it will be found that the increase in cost of lifting due to a small and intermittent supply, will render them more a source of loss than profit to the Assami, and they fail utterly in very dry years unless carried to such a depth as to render their cost prohibitive

The profit on expensive wells doubtful.

96 The cost of a masonry well depends directly on the depth of the true mota, this may be great even though the sub-soil water surface is high, in such cases and in instances when special means, such as pipes, &c., are used, the Revenue officer alone can tell whether the transaction will be a paying one or not, and that within wide limits, as the final result both as regards expenditure and success is always doubtful

Bricks.

97 The best description of brick to use for wells depends on the mortar, if this is good, large voussoirs may be employed for the cylinders, but when the quality of the lime is doubtful, small country bricks are to be preferred, plenty of water should be used, and a long time given to the work to set

Percolation into water-courses.

98 A matter intimately connected with the construction of wells is the loss due to percolation from water courses This seriously interferes with the success of large wells From Abstract Table O it appears that the mean loss is about two cubic feet per foot run, during a day of 9 hours, and that the loss of area varies from 30 to 50 per cent per well for a water-course 500 feet long Some experiments recently made by Mr Beresford on the Anupshahr Branch, Ganges Canal, showed out of a total supply of one cubic foot per second a loss of 0 5 cubic foot per second in a distance of 1 5 miles, the soil being sandy for one mile, this for a day of 9 hours = 2 0 cubic feet per foot run, and the results shown may, therefore, be assumed as fairly correct

Can be prevented.

99 This loss can be entirely obviated if the channels are lined with an impermeable material, and if pipes or concrete are used the cost will amount to about Rs 10 per 100 running feet

Cost of masonry channels

100 The maximum annual area irrigable by a 4-lift well at 30 feet to water surface is shown as 60 acres The best disposition of this area will, I think, be a parallel strip with the well in the centre on elevated ground, and this is not an uncommon arrangement of area for large wells, and suits the natural lie of the country, as the channel will be on the watershed with the irrigable area gently sloping on both sides

The width *ab* (*Fig* 17, *Plate* II.) should depend on the nature of the soil, but if for the 4-lift well we assume it at 400 feet, we find the length of permanent water-course required will be $\frac{34 \times 43560}{400}$ feet — 800 feet = 3,000 feet, which at Rs 10 per 100 = Rs 300, and even assuming that it only saves one cubic foot per foot run, the amount spent will more than cover the cost of construction of a well capable of supplying 3,000 cubic feet per day, and entirely save the cost of re-lifting the actual water It would, therefore, appear advantageous to add permanent channels to all wells built by Government The cost will vary from 50 per cent of direct construction in the case of low lifts, to 12 per cent. for a depth of 60 feet, or nearly 10 per cent. per foot of rise in water surface, and this will also tend to equalize the rate per acre to be charged.

A rate of Rs. 2 per acre necessary to cover cost of construction.

101. Taking all contingencies into consideration, a round rate of Rs 2 per acre of annual irrigation appears to be the mean charge required to cover outlay

COST OF WELL IRRIGATION

Cost variable.

102 There are few wells to be found in the Doáb from which irrigation is carried on under precisely similar circumstances Climate affects the number and depth of the waterings given, and there are marked variations in the characteristics of the cultivators, cattle, wells and methods of lifting water

Estimate possible

103 The one advantage we possess in attempting an estimate of the cost is, that each individual well or cluster of wells is a fixture in its own plot of land, the boundary of which can be determined with reference to surrounding wells, and the maximum quantity of water which can be lifted in a day

Division of cost.

104 Every crop that is watered from a well bears a cost over a dry crop, the total of which is made up from three main heads, *viz* —

A Interest on capital
B Annual charges
C Cost of lifting the quantity of water required

Dry crops

105 The word dry is intended to refer to crops raised in lands unprovided with wells, as even when owing to the necessary quantity of rain having fallen, well lands are not watered, they have still to bear the yearly interest charges

A —*Interest on Capital*

Interest.

106 The capital invested is the necessary cost of construction of the well with its fittings, and this varies from Rs 2 to Rs 1,000 with the class of well and advantages of the situation

The cost and description of the different kinds of wells and fittings met with in the Doáb have been already given, and the detail of those examined will be found in Table A., columns 44 and 45 It was impossible to ascertain with accuracy the cost of very old wells, and even in the case of those recently built, it is difficult to fix the exact expenditure, both home materials and labor are used, the construction is often spread over a long period, and few Zemindars keep accounts, but a fair idea can usually be formed from a due consideration of the difficulties met with, the facilities for obtaining material, and the relative cost of similar wells, the expenditure on which is known When no other means were available the sum was fixed at about one-half of what it would cost Government to build such a well

In Table G the interest at 5 per cent. of the cost of the experimental wells is distributed on the area actually irrigated during the year—both rabi and kharif In many instances there was no kharif irrigation, in others it was difficult to ascertain correctly When such was the case one-half of the rabi was added for kharif to make up the yearly irrigation, and the incidence of the rate is shown on this area

Rabi irrigation.

107 The rabi area is made up of crops which require a different quantity of water at various intervals, the maximum rabi area which can be watered, therefore, depends on the quantity of water raised and the crops grown

Periods of crop growth

108 Table D shows the periods of crop growth for the districts examined It is compiled from the famine replies, and the mean number of waterings and intervals between waterings entered were collected from personal enquiry

Intervals between waterings

109 The intervals multiplied by the waterings do not always fit in exactly with the length of time the crop is shown in the ground, but this is only to be expected, as the waterings shown are those required in years when the cold weather rainfall is deficient, and the intervals the maximum the crop will remain uninjured without water

Percentage of crops irrigated

110 The wells experimented on were, as far as could be managed, the best in each village visited, and the line of country was chosen so as to bring every class under examination, and Table B shows the actual area irrigated by crops per well, lift, and pair of cattle or man employed lifting water The mean area and the percentages of crops for each district are shown, and also over each crop area the actual statement of the Assami regarding the number of waterings required is given

Days required per watering

111 Table F shows the number of days required per pair of cattle or man actually lifting water to irrigate an acre at three different depths of watering, and by division, or addition, of these depths, the number of days required for any given depth can be readily obtained

Depth of waterings

112 The mean depth of watering given in each district per crop is shown in Table B, and the same reduced by the loss from absorption in water-courses in Abstract Table C

Information in Tables

113 We have, therefore, for each well, village and district a close approximation to, if not actual

Depth of watering in feet,
Number of waterings required,
Working days to the acre,
Intervals between waterings,
Percentage of crops grown and periods of growth,

and it is then a simple calculation to determine the maximum area which can be irrigated of any fixed proportion of crops, or of the percentage suitable to the district in which the well is situated

The cost by Districts and lifts

114 Table H shows a final result for districts The figures for those in which there were a large number of experiments are naturally most to be depended on, and fortunately this occurs in the best irrigating districts

The rabi irrigating season.

115 A reference to the abstract of Table D will show that, rejecting carrots, potatoes and tobacco, and making due allowance for ripening, the average time available for watering the rabi may be fixed at 180 days, but except in the case of wells on which a large number of cultivators per lift work jointly, this period must be considerably reduced The same cattle cannot be worked more than 20 days in the month at such severe labor without serious injury, indeed this is the period generally given by cultivators themselves as a maximum, nor will any except the best wells stand such a constant strain It will be safe however, to assume 120 working days as available, as few wells have less than two cultivators working at them When potatoes, tobacco and carrots are grown this period is often exceeded, but wells which take 150 days to water their rabi crop area may be considered as fully worked, and from Table G we find that the mean interest rate on cost of construction per acre on $\frac{3}{2}$ of the maximum rabi area is Rs 4 for Muttra, when the depth to water surface is great, viz, 60 feet, and the wells are nearly all masonry, and Rs 1-8-0 for the other districts, with a mean depth to water surface of 30 feet and all classes of wells

Assumed maximum not reached in practice.

116 Only one fifth of the wells examined attained their assumed maximum rabi area, the figure cannot, therefore, have been fixed too low, many had no kharif irrigation, and in only two did it exceed the allowance made of half the rabi area, the actual rate per acre in 1881 83 must, therefore, in the majority of cases have been far above the figures given

Wells with no rabi irrigation

117 Some wells have no rabi area Kucha wells are dug in both Bundelkhand and Rohilkhand solely for sugarcane irrigation, which is often watered when other crops are grown dry

Number of wells or units required for a given area.

118 A considerable difference of opinion exists as to the total area which should be allotted to each well, or rather to each unit (*see* para 4) We find in Table H the mean yearly command for each district per unit, but even in the most closely cultivated tracts of the Doáb there is fallow, or land not cultivated in either the kharif or rabi of the same year, so that, even were the whole cultivated area yearly irrigated, which it is not, we could not get the number of units required by dividing the total area by the unit area It will be seen also (*vide* Table C) that there is a serious loss of water when taken a long

distance, and cultivators are fully aware of this,* yet the disconnection of the tracts of mota and the mixture of good and bad land in many places necessitates either the isolation of the irrigation, or the carriage of the water for a long distance, in which case the available unit area would perhaps not be worked up to

Sample cases

119 With reference to the proportion of cultivated land which is yearly irrigated, I had hoped, but have not had time, to give some examples showing the allotment of irrigated and dry crops in certain type villages over a series of years, it would be found to be curiously permanent Occasionally Assamis hold land in two parts of the village, usually termed the "har" and "chahi," in the *har* they cultivate rain and dry crops,† and round their wells those which they wish to water, and in highly irrigated villages this land is frequently double cropped, (a reference to Table A, column 11, will show that the double cropped area increases in a marked degree with the percentage of well irrigation,) adding another to the many difficulties of the estimation

Actual figures available.

120 Statistics showing the actual area commanded by each unit of irrigation might be obtained by recording the fields irrigated from certain selected wells over a term of years, but the variations are so great in individual wells, that this would be necessary for a large number of cases to obtain an average figure Perhaps the best approximation is to be found by dividing the number of units in highly irrigated villages into the cultivated area It is necessary to select villages which irrigate from no other source than wells, and from the villages examined presenting the maximum percentages, it is evident that there is a considerable difference in the proportion which the total area ever irrigated bears to the area actually irrigated in any one year by each unit, as it varies from 7 to 150 per cent of the year's irrigation, even when the percentage of the total area of the village irrigated is large It is influenced mainly by the nature of the soil with reference to its powers of being double cropped, and the class of cultivator, and although for a general estimate we may assume the proportion of *cultivated* area to be allotted to each unit at double its power of yearly irrigation, yet it is evident that the exact allowance to be made should be carefully worked out from existing examples for every tract taken specially in hand

Difficult of estimation.

121 The above remarks will, it is hoped, convey an idea of the difficulty of correctly estimating the gross cultivated area which should be allotted to each well under the mixed agricultural conditions which exist in the Doáb

Rate must be struck on yearly irrigation.

122 This apportionment of area is only important so far as it effects the mean rate to be borne by the gross area commanded, and the correct distribution of wells It must be remembered that the interest charge is yearly, and that therefore the area yearly watered has really to pay the whole interest, and this simplifies the calculation considerably For the double cropped a most embarrassing item of the gross area need not be considered, the maximum yearly command being independent of it, and the construction rate in consequence is calculated on this area, and I think it will be admitted correctly so

123 Few except those who have enquired into the history of large heavily worked wells can be aware of the complicated nature of the cultivator's agreements and arrangements regarding them

Rath wells

There are two sets of four wells each in Rath Hamirpur, from which no less than 61 *Karhus* irrigate, every man having his particular number of hours or days of work laid down, which were fixed with reference to the share of cost of construction he or his forefathers paid, and so accurately have they estimated the area they can water, that the crops are uniformly good, although they consist of tobacco and opium, both of which suffer seriously from any delay in watering, and these are heavily worked wells with a maximum unit area—*see* Appendix VIII

Sitapur well

124 Again in Sitapur, Aligarh, *vide* Appendix VII, there are two 8-lift wells working 28 and 32 head of cattle per well respectively On these all the cultivators work jointly together, and actually count the number of lifts made, so that each day's work may be alike Now every Assami on these wells has a different area at varying distances, and

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*In detailing the time required to water distant fields they often state double the period required for those near the well, and give the distance as a reason.

† The same crops are often cultivated in one village both wet and dry Part wet to make a certainty of some return from the cattle available, and part dry in hope of rain

with crops requiring different depths, waterings and intervals How complicated their accounts must be can be imagined, and many other instances could be quoted

Cost of kucha wells.

125 The relative cost of deep masonry or dry brick wells compared with shallow ones is great, it is not so in the case of those which are kucha. The almost universal rate fo excavation down to the mota when wet sand is not met with is Rs 1-4-0, whether the depth be 20 or 60 feet, *the earth taken out is used for the ramp, and the explanation of the fixed rate is simple, as even a 60 feet well will not give sufficient earth for a ramp* A special class of workmen are paid 4 annas a day, each to cut the hole in the mota and prepare the bottom of the well for the bucket This costs from Rs 1 to 3, so that even a 60 feet kucha well can be built for Rs 5 if no difficulties are met with, and it may last 100 years or more with no repairs but a yearly cleaning out.

When wet sand or any stratum which will not stand without support is met with above the mota, a lining has to be added, which costs an indefinite sum, varying from 8 annas to Rs 10, and has usually to be renewed yearly In these cases the well is short lived, and in Table A. interest is charged on the cost of construction, divided by the average number of years wells last in that particular tract

Cost of kucha wells dependent on sub-soil.

126 It may be seen, therefore, that the cost of *kucha wells* is influenced *directly by the nature of the soil* *Masonry wells* are practically independent of the nature of the sub-soil so long as a mota exists, they are sunk rather easier through wet sand than clay, and when well built require no other repairs than a yearly cleaning out, their cost therefore depends *directly on their depth.*

Wood lined wells.

127 Wells lined with wood or other semi-permanent material are considered as kucha, and their cost calculated accordingly

The people constantly build kucha occasionally dry brick and wood lined, and very sel-dom masonry wells, directly for irrigation, the reason is obvious, as no crop could bear a direct charge due to a very deep masonry well, but happily the results of their religi[ous] feelings here tend to the prosperity of the country

B —*The Annual Charges*

Annual charges.

128 These have been referred to before, and consist in—

(1) Renewals or that proportion of the first cost of the well which it is necessary to charge yearly to provide for its necessary re construction
(2) The cost of the lift.
(3) Repairs

These require no further explanation. They vary with nearly every class of well, and fair average rates for the interest and annual charges combined will be found in Table A for each district

C —*The cost of lifting the quantity of water required*

Cost of lifting water

129 This is a simple matter to determine, compared with the interest charge, for an average number of hour's work in the day (which has been assumed at 9 for the calculated Tables), a co-efficient can be fixed for any well with its cultivators and cattle

The mean cost of lifting 100 cubic feet of water from wells in the Doab is 0·454 of an anna,* and this has been determined by measuring the quantity lifted during the whole day from more than 150 wells distributed over a large area It varies naturally a good deal with different class of cultivators, bullocks and wells The full details of experiments will be found in the Tabular Statements, and it is certainly remarkable to note how similar the results are, within certain boundaries which are roughly defined by the various districts, and this shows the great errors that may be made by predicating any general principles from purely local enquiries

Work done.

130 The work done by any number of bullocks or men at a well is made up of frictional resistance overcome, water, and dead weight lifted, the results of the day's work is

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* Cattle Lagor	= 0·514	Men Dhenkli	= 0·183.
Men ,,	= 0·624	,, Rati	= 0·165
Cattle Kili	= 0·330		

given for each well in Table E, friction having been neglected, for it is difficult or impossible to estimate accurately, and the resistance due to it is so much effected by the quantity of lubricating material applied to the pulley, that its admission into the calculations might prove a source of serious error

From the work column in Table F it will be seen that the percentage of—

Useful work.

131 *Useful work—decreases* directly with the depth to water surface with cattle, *increases* directly with the capacity of the lift

Is a maximum with Dhenklies and Ráths, in which there is no loss but friction, and is not much effected by the depth in the case of coolie lifts, as men turn quickly

Total work.

132 *The total work done per head**—Is a maximum with cattle working Kili, *vide* No 492, where 3 064 foot tons per minute were lifted

It is a minimum with hired men working a Dhenkli, *vide* No 501

Decreases as the number of cattle on each lift are increased, (but cost also decreases)

Is practically identical for men working Lagor, the actual figures for the five wells experimented are—

No of men.	Depth to water surface.	Foot tons per head per minute.
6	31	0 487
6	35	0 488
6	30	0 472
8	17	0 440
7	38	0 477

Some of these men were hired, some home labor, the agreement in result is curious, and one ton lifted 6 inches high in one minute may be taken as the maximum work a man can do at such labor

The foot ton the co-efficient

133 The foot ton per minute is the co-efficient of the well, and is a more convenient figure than the actual horse-power which, however, can be approximated by dividing it by 15 The mean weights of the various sizes of lift used, Lagor and Kili, are as follow —

Up to 2 cubic feet, 14 lbs 2 „ 3 „ „ 16 „ 3 „ 4 „ „ 20 „ 4 „ 5 „ „ 24 „ 5 „ 6 „ „ 28 „ 6 „ 7 „ „ 32 „	This is including the ring, which increases the proportional weight of the larger lifts, as it is then usually made of iron The following formula was used in working out the work done —

$$\text{Height of lift} \times \left\{ \frac{\text{Cubic feet lifted} \times 62\ 33 + \text{No of lifts} \left(\text{weight of lift} + \frac{\text{weight rope}}{2}\right)}{\text{No. of cattle or men} \times \text{No of minutes} \times 2240} \right\}$$

The height of lift taken is the maximum, as it is from that depth the water is drawn over the greater part of a day's work The result of the formula is not strictly accurate, but very nearly so

Depth of watering

134 The depth of water given to the various crops is shown in Table E, it was obtained by dividing the number of cubic feet lifted during the day into the area irrigated during the same period, and as far as its useful effect is concerned should be reduced by the loss from percolation consequent on the length of the water-course

Considering the extended area over which the observations were made, and the variation in climate and soil, the depths agree so far as to show a marvellous knowledge of his business in the Assami, who it could be wished would display a similar care when dealing with canal water

How varied by soil.

135 With regard to soil, it is probable that the rate of evaporation is the principal factor that determines the quantity of water given As the depth of damp is greater in

* Cattle or men

sand than in *matyar* or *dumat*, so presumably the evaporation is slower I failed, however, to gather any substantial facts showing that any difference is made in the quantity given to the different soils by the Assami The amount is so much more varied by the disturbing influences of cost, depth of well, distance of field, quality of cattle, climate, &c, &c, that a rule will with great difficulty be discovered, and cattle or men be of but local application.

The depth and number of waterings given in the Tables are those for a rabi season of deficient rainfall after a good kharif, and 1881-82 was an eminently favorable year for observation

Mean depths

136 The following may be taken as a fair average of the depths given in feet —

Crop	First watering	After waterings.
Wheat,	2500	1860
Barley,	1860	1860
Tobacco,	1860	1250
Opium,	1860	1250
Carrots,	1860	1250
Potatoes,	1860	1250
" in ridges,	1250	0930
Gardens,	·0930	0930
Sugar,	2500	2500

Subsidiary crops.

137. Subsidiary crops are usually given the watering required by the major crop

Depth of damp in soil.

138 The depth of damp occasioned by a watering appears to be more affected by the depth of ploughing than by the percolation power of the soil, except in very sandy tracts

Deep ploughing

139 The advantages of deep ploughing as a water retaining measure is here patent, and this perhaps tends to explain why sandy soils have fewer waterings than those of a more clayey nature

Labor rates.

140 The labor rates charged have been already remarked on, they are as follows —

Bullocks,	8 annas per pair,	to cover share of purchase " " renewals " " food while working
Coolie labor hired,	actual rates paid varying from 2 annas to 6 pies	
Labor home,	one anna per day, deducting one man from the total number employed during the day	

Bullocks —This rate can scarcely be reduced, it, however, seriously influences the relative cost in districts working bad cattle The charge for good bullocks should really be raised, but it would have caused much complication in the calculations

Home labor —A man can live on less than one anna a day, but the work is very heavy, particularly coolies working Lagor

Net rates per crop

141 The actual and mean rates are worked out in Tables G and H, and the following rates may be taken as representing the net outlay incurred over the Doáb

Crop.	Rs	As.	Crop	Rs.	As.
Wheat,	8	0	Carrots,	10	0
Wheat and barley,	7	5	Peas,	2	5
Wheat and gram,	7	0	Oats,	10	0
Barley,	6	0	Opium,	15	0
Barley and gram,	5	0	Tobacco,	15	0
Barley and peas,	5	0	Potatoes,	12	5
Safflower,	4	0	Garden,	12	0
Safflower and carrots,	6	0	Sugar-cane,	12	0
Gram,	2	5			

The above rates only cover cost of food for labor

Calculations for Dhenkli and Rátis imperfect.

142 From the calculated rates it appears that the Ráti is the most economical, and coolie Lagor the dearest method of raising water, but it is necessary to note that in a single

Ráti or Dhenkli two persons are employed, and that owing to the principle of excluding one person on each well from the calculations of cost, only one person per day is charged, and at one anna, as Dhenkli and Ráti are almost universally worked by home labor. If however the cost of lifting by these methods is even doubled, it will still be cheaper than any other system for the same depth, but it is very slow, and when the number of lifts is increased the area of land taken up is considerable, and if culturable its value must be added The loss from percolation, also due to several small water-courses, would be greater than in the case of a *churrus* well

Rate lower than those calculated by Major Erskine

143 These rates are considerably below that arrived at by Major Erskine, the Secretary to Government, Oudh Revenue Department, in office memo No 2252, dated 16th August, 1881, and the difference is due to the assumption of lower labor rates, the now known reduction in quantity of water used for secondary irrigation, and also the marked variation in quantity which different crops are given

Comparison with canal rates.

144 That these rates represent outlay similar to the actual cash paid for canal water there can be little doubt, and the comparison of rates is instructive, *vide* Appendix XII

145 *The total charge for well irrigation per acre*—The actual total charge for each crop cultivated during the rabi on every well experimented on is shown in Table G, and in the Abstract the mean rates for each district, these rates are at their lowest point, when 150 or more days are required to irrigate the rabi area, and therefore in consulting the record for fair rates such examples should be examined

There is no difficulty in working out from the tables the maximum rabi area for any well for which the crops to be grown and the quantity of water which can be lifted each day are known

It will be seen from Table B that, excluding the northern districts, a larger variety and higher class of crops are irrigated in good Kuli than in Lagor tracts, and the extent of rabi area will be modified accordingly

Rule for calculating mean rate of watering

146 Taking the percentages of crops given in Table B and the mean work from Table F, the mean rates for each class and lift can be obtained by multiplying the percentages of crops by the number of days required to water an acre of each, and dividing the total by 100, we thus get the number of days required to water an acre of the average crop, and this figure divided into 150 days will give the rabi command By adding 50 per cent we have the maximum area which can be yearly irrigated in the kharif and rabi, and the following Table gives the figures for the different districts and classes, and also the cost at cultivator's rates for a suitable well, when the mota can easily be reached It is evident that highly irrigated crops should pay a larger share of the total rate, but for general purposes it may be equally divided.

TABLE K —*Maximum area which can be yearly irrigated and Interest Rate*

District.	Class.	Labor	Depth to water surface.	Maximum Area per Unit: Rabi	Maximum Area per Unit: Kharif	Maximum Area per Unit: Total.	No of units per well.	Area per well	Capital Cost: Well	Capital Cost: Fittings	Capital Cost: Total	Annual: Interest at 5 per cent	Annual: Lifts.	Annual: Total	Rate per acre.	Remarks.
Cawnpore,	Lagor	Cattle	47	5 0	2 5	7 5	2	15	285	5/-	290	14 5	14/-	28 5	1 9	All crops.
Hamirpur,	"	"	40	4 2	2 1	6 3	2	12 6	250	6/-	256	12 8	13/-	25 8	2 0	"
Farukhabad,	"	"	47 5	6 0	3 0	9 0	1	9 0	220	3/-	223	11 2	8/-	19 2	2 1	"
Mainpuri,	"	"	20	7 5	3 75	11 25	2	22 5	150	6/-	156	7 8	17/-	24 8	1 1	"
Etah,	"	"	17 8	5 3	2 65	7 95	2	15 9	140	6/-	146	7 3	16/-	23 3	1 5	"
Shahjahanpur,	"	"	34 5	7 1	3 55	10 65	1	10 65	170	3/-	173	8 7	9/-	17 7	1 7	"
Lucknow,	"	"	31	3 3	1 65	4 95	2	9 9	200	5/-	205	10 3	7/-	17 3	1 7	"
Hardui,	"	"	30	3 4	1 6	5 0	3	15 0	220	6/-	226	11 3	7/-	18 3	1 2	"
Saharanpur,	"	"	23	3 6	1 8	5 40	1	5 4	130	3/-	133	6 7	6/-	12 7	2 3	Garden.
Shahjahanpur,	"	Men	31	3 2	1 6	4 8	3	14 4	150	3/-	153	7 7	5/-	12 7	0 9	All crops.
Lucknow,	"	"	27 3	3 7	1 8	5 5	3	16 5	140	3/-	143	7 2	5/-	12 2	0 7	"
Hardui,	"	"	38	3 2	1 6	4 8	3	14 4	200	3/-	203	10 2	5/-	15 2	1 0	"
Aligarh,	Kili	Cattle	28	7 0	3 5	10 5	3	31 5	240	7/-	247	12 4	20/-	22 4	0 7	"
Muttra,	"	"	61	5 5	2 75	8 25	2	16 5	360	6/-	366	18 3	15/-	33 3	2 0	"
Etah,	"	"	22	8 3	4 15	12 45	2	24 9	160	6/-	166	8 3	18/-	26 3	1 0	Only two exa... ples.
Bulandshahr,	"	"	24	6 1	3 1	9 2	3	27 6	220	7/-	227	11 4	20/-	31 4	1 1	All crops
Meerut,	"	"	26	7 0	3 5	10 5	3	31 5	230	7/-	237	11 9	20/-	31 9	1 0	"
Muzaffarnagar,	"	"	18 8	5 0	2 5	7 5	4	30 0	230	3/-	233	11 7	10/-	21 7	0 7	Only one e... ample
Bijnor,	"	"	16	3 7	1 85	5 55	4	22 2	200	3/-	203	10 2	9/-	19 2	0 9	Calculated as wh... 50 per cent. ... watering and ... den 50 per cent.
Moradabad,	"	"	19	6 5	3 25	9 75	2	19 5	140	5/-	145	7 3	9/-	16 3	0 9	All crops.
Bareilly,	"	"	38	3 7	1 85	5 55	1	5 55	180	3/-	183	9 2	8/-	17 2	3 0	"
Shahjahanpur,	Dhenkli or Rati.	Men	20	1 0	0 5	1 5	1	1 5	3 0	1/-	4 0	0 2	1/-	1 2	0 8	Garden kuch... wells.
Farukhabad,			16	1 4	0 7	2 1	1	2 1	6 0	1/-	7 0	0 4	1/-	1 4	0 7	"
Bijnor,			21	0 9	0 45	1 35	1	1 35	3 0	1/-	4 0	0 2	1/-	1 2	0 9	"
Moradabad,			13 3	1 8	0 9	2 7	1	2 7	2 0	1/-	3 0	0 2	1/-	1 2	0 5	"
Bareilly,			9	2 0	1 0	3 0	1	3 0	2 0	1/-	3 0	0 2	1/-	1 2	0 4	"
Hardui,			10	4 0	2 0	6 0	1	6 0	4 0	1/-	5 0	0 3	1/-	1 3	0 2	"

The figures in column "maximum area per unit rabi" should be contrasted with the mean results at end of Tal... B—which show actuals

Table K. shows also the incidence of the annual charges per acre, but it is evident that these figures are the very lowest that can possibly be worked to under the most favorable conditions

Cost of irrigation for standard crops

147 For purposes of comparison the total cost of irrigating one acre each of wheat, opium, and sugar are given below

TABLE L

District.	Wheat					Opium					Sugar.					Remarks
	Kili	Lagor	Men	Dhenkli	Râti	Kili.	Lagor	Men	Dhenkli	Râti	Kili	Lagor	Men.	Dhenkli	Râti.	
Cawnpore,		11 9					14 9									The rates vary according to the number of waterings given and the quantity of water lifted per unit
Hamirpur,		10 2					14 7					16 0				
Farukhabad,		12 6		4 6			16 4		5 8							
Mainpúri,		8 1					15 8					12 3				
Etah,	7 5	12 8				11 5	19 4				9 0	15 5				
Aligarh,	7 6					15 7										
Muttra,	10 7															
Bulandshahr,	9 0										11 1					
Meerut,	8 0										14 4					
Muzaffarnagar,	8 1										12 2					
Saharanpur,						15 3										
Bijnor,											9 7			6 9		
Moradabad,	3 5			1 5							9 3			4 5		
Bareilly,	6 0				2 1											
Shahjahanpur,		3 7	4 0	2 0	1 9							5 7	7 1	4 0	2 8	
Lucknow,		17 1	7 7				21 8	9 7				27 0	10 8			
Hardoi,			8 0	2 3	2 7			11 1	3 5	4 1			26 0	7 7	9 3	

Value of produce.

148 Great difficulty has always been found in estimating the gross produce of an acre of any crop, and even when found, it is sometimes impossible to fix the value accurately The subsidiary crops often give more profit than is generally thought, and indeed it is hard to understand how the Assami in some districts continues to farm unless the gross outturn is much greater than existing statistics lead us to suppose

Opium.

149 The Opium Department Administration Report of 1880-81 gives the average produce per beegah for 1880-81 at 4 seers $3\frac{1}{2}$ chittacks, this equals 6 75 seers per acre, and at the value given, i e, Rs 5 per seer, equals Rs 33-12-0 per acre, and the minor profits will probably bring this up to Rs 35 Deducting the greatest charge for watering this, leaves Rs 20 to cover rent and cultivation

Wheat.

150 Mr W Crooke, C S, the Manager of the Court of Ward's Estate, gives the following as the outturn of wheat in 1880-81 from an actual experiment.

Wheat.	Total area sown.	Total yield. m	s.	ch.	Produce per acre m.	s.	ch.	Remarks.
Canal grain,	7 64	120	19	0	15	31	0	Well outturn best, but crop Muzaffarnagar white wheat showed a stronger tendency to revert to the local type with well than with canal water
" bhusa,	..	178	10	0	23	16	0	
Wells grain,	6 25	111	32	8	17	38	0	
" bhusa, ..	1	164	0	0	26	13	0	

The value of this produce is probably not under Rs 26, which leaves a margin of nearly Rs 20 as in the case of opium

151 The value of the sugar crop varies greatly according to the class of cultivation. In Lucknow and Hardui the crops examined were fine eating cane, which explains the high cost of irrigation, and at the average rate from even moderate crops, there will remain a large margin to cover cultivation and profit, *vide* Shahjahanpur Settlement Report, sec 11, para 37

A rate of Rs 2 necessary to cover interest on construction.

152 From the calculations which have been made of the cost of irrigation from wells, the result arrived at has been that a rate of Rs 2 must be charged on the maximum area irrigable in the year, to cover the expenditure on construction under the most favorable conditions, and that the cost of the food consumed by the labor employed to fully water any crop will amount to about 30 per cent of its gross value

The calculated area a maximum.

153 The maximum area as calculated is certainly 100 per cent over the average arrived at in practice, this is evident from the areas shown in column 35,* Table A, and from the figures kindly collected for me by Mr A Harrington, C S, *vide* Appendix IV, where the average of 3,716 lifts gives 3 acres as the mean area irrigated in the rabi, and 5 acres as the maximum area irrigable in the year The actual area irrigated in the year being only 3 21 acres, and this in Rai Bareilly, where the mota is plentiful and taccavi advances have been freely taken It is evident that there is no room for expansion in these figures Well, unlike canal irrigation, is not elastic In famine years the possible area from wells is reduced by the weakness of the cattle and men, the increased depth and number of waterings required, and the diminution of the supply, while canals being snow-fed, the supply is increased by drought, and the area by the greater care taken with distribution, we have nothing therefore to hope for from an increase in area, and it is clear that purely hired labor cannot be extensively employed, for not only would the cost of irrigation be enormously increased, but the daily work done would be reduced

Percolation wells costly to irrigate from.

154 Percolation or wells with a bad supply are not only in general more costly to construct, but much more expensive to irrigate from than mota wells All the calculations of work have been made on the assumption of a good supply being available, the qualifying factor being the power of the men and cattle If, however, they have to stop constantly to allow the supply to accumulate in the well, the amount of work they can do in the day will be lessened

Well construction by Government cannot, I think, be successful in tracts in which there are either too great or too few facilities for irrigation, and unfortunately the districts first selected for experiment suffer doubly on these accounts

Cawnpore wells.

155 In Ghatampur, Cawnpore District, the depth to water surface is 60 feet, this limits irrigation to the most favorable soils and crops, and increases greatly the charge per acre due to construction, and close to the wells which have been built, costing about Rs 250 each, good kucha wells, costing Rs 15, and giving an equal supply, are not impossible.

Moradabad wells.

156 In Moradabad exactly opposite conditions prevail—water is 10 feet from the surface, and the mota, though not unknown, is very scarce, owing to the climate, however irrigation, though desirable in ordinary years, is only absolutely necessary for a few crops, and a limited number of waterings is given It has been shown that the cost of irrigation by Dhenkli and Rátis from a depth of 10 feet is much cheaper than by cattle from a depth of 20 or 30 feet, and it appears quite certain that the wells now being built, except when on the mota, will not give a sufficient supply for *churrus* working until the water surface has been reduced to 25 feet to give the necessary head The yearly command of area in Moradabad may certainly be fairly fixed at a higher figure than in Cawnpore, as a less number of waterings is necessary, but the cost of the wells is also greater, and the charge for an annual Dhenkli well is insignificant Both classes will suffer in drought, the masonry well probably the most, as it will give no supply at all if the sub-soil surface falls considerably, while Dhenklis and Rátis can be worked up to 25 feet We must, therefore, look with diffidence for favorable financial results from these experiments

Interesting as a scientific experiment.

157 The Moradabad wells are most interesting in an Engineering sense, for except

* Column 35 shows the area in acres per lift, and in many instances two or three units or pairs of cattle are used per lift ; this is noted in the column of Remarks

in the few instances when a clay or kunkur layer has been met with, the cylinders rest on pure sand, from which, as before noted, it is impossible to directly draw water without injury to the well Wood and iron pipes from 5 inches to 8 inches diameter have been sunk to depths varying from 10 to 80 feet below the bottom of the wells, but except in one or two instances without meeting with any mota.

Three main experiments have been made—

1st —With the pipe head resting in sand, the well having no bottom Depth of water = 20 feet.

2nd —With the pipe head resting in ballast, forming a permeable bottom to the well, which admitted of supply both from the area of the bottom of the well and from the pipe. Depth of water = 16 feet.

3rd.—With the pipe head embedded in concrete, forming an impermeable bottom to the well, all the supply had to come through a pipe 5 inches internal diameter Depth of water = 16 feet

The first experiment was made on a number of wells, and resulted in a rapid exhaustion of the water, the sand rising several feet into the wells causing the cylinders to sink.

The second experiment gave similar results.

The third experiment was carried out on the Chak Dhunowrie a 2-lift well. On the first two days water sufficient for one lift was obtained without injury to the well, but not until the surface had been reduced about 12 feet On the third and following days, when work was stopped and the water was allowed to rise in the well, a sand discharge took place from the pipe, which had remained clear during the day * Full reports on this experiment have not yet been received, and it may be possible to form a pocket of ballast at the bottom of the pipe which would stop the sand draw, but a largely increased supply cannot be anticipated

Appendix IX. gives the progress of the wells under direct construction by Government up to the 11th May, 1882

The experiments might judiciously have been confined to one or two wells until the possibility of construction in such a position had been demonstrated

Extensive projects not advisable.

158 Great care must, therefore, be exercised in the selection of suitable sites, and all natural advantages secured, and this I fear will seriously prejudice the chances of the success of any large project Well irrigation has been practised for such a long period, that the people have already extended irrigation to very near the natural limits of "available labor," "necessity for water," and "the power of obtaining it cheaply" A careful study of the statistics in Table A. will show that the percentage of the cultivated area irrigated in tracts of equal demand, very fairly corresponds with the opportunities of obtaining the supply, and I fear all that we can do with a prospect of financial success is to fill up the gaps that remain, and above all attend to the repairs of existing, though injured, wells, which very often only need the necessary tools, advice and a small advance

The best irrigation in Canal districts.

159 Excepting Muttra, where there are strong indications of exhaustion of the sub-soil supply, the best well irrigation occurs curiously enough in canal districts and I think the explanation is to be found in the increased prosperity of the people which enables them to keep better cattle, and the tracts in which the sub-soil water level has been raised by percolation from the canal offer the greatest advantages for well extension. I have not as yet been able to get the agricultural statistics of the villages in the Aligarh District recently debarred from canal irrigation, but I am confident it will be found that they have even now, very nearly as large a percentage of irrigation from wells, both new and old, as they had formerly from the canal, and this without advances †

Tracts with artificial high water surface the best for Government wells.

160 There are many advantages gained by selecting such tracts for wells, the water is near the surface, money and cattle plentiful, the best possible drainage system is adopted, and the canal supply can be utilized in places where it is more needed.

* This result is very curious.

† Since received, vide Appendix II.

The Bulandshahr District

161 The Bulandshahr District also offers facilities for extension of well irrigation, particularly in those parts of parganas Ahar, Shikarpur, Sahana and Anupshahr, to which the canal does not reach, the mota is scattered, but suitable positions for wells will be found in most villages, there is plenty of good *dumat* soil, the best for the purpose, *and the existing irrigation is high class* Mr S Growse, C S, the Collector, kindly obtained the statistics of the worst villages for me, they are too voluminous to be put up with this Report, but will be forwarded to the Director of Agriculture separately

Advances.

162 Direct Government agency being deprecated, the arrangements for advance and recovery of the interest become matters of great importance Zemindars do not care to take advances, even if anxious to improve their estates, for they, like Government, are not certain of financial success unless they are self-cultivating, and advances cannot be made to individual tenants for want of security

How best made

163 But we find few wells worked by a single cultivator, a community is more stable than an individual, and if joint agreements, fixing shares, &c, between the Zemindar on the one hand and the cultivators interested on the other, were arranged by the advancing officer, the Zemindars in most cases would give the required security, particularly if the interest were not payable as such, but as a fixed charge per acre on the land benefited, the advance being regarded as what it truly is, *viz*, sunk in the ground for its permanent benefit

Khára wells.

164 The water of certain wells is bitter, called *khara*, which is caused most probably by solution of salts in the soil, as such wells are only found in certain localities, notably Muttra The water of these wells is said to be good for the rabi, if rain also falls, but not alone, not good for indigo or cotton, but it is always preferred for tobacco

Kyaries.

165 With reference to canals, attention may be drawn to the great importance of Kyaries, the compartments into which the field is divided, and on which the whole system of distribution depends The quantity of water used for irrigation per acre by canals is three times as great as by wells, and a strict adherence to Kyaries should result in an enormous extension of area

Decrease in culturable area

166 Another point of consideration is the power canal water possesses of bringing culturable land into cultivation, very poor land will often not repay the cost of well water, but the charge is so low, that when canal water is newly introduced into a village it has a strong tendency to lower the percentage of culturable area, if properly distributed, *vide* Appendix VI.

Extract from Diary

167 A general account of the villages visited is given in Appendix X.

Apology

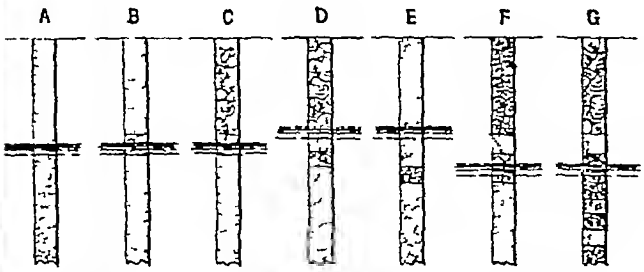
168 In conclusion, I trust that the imperfections and length of this Report will be forgotten in the interest which attaches to the subject. I may add that the letterpress is chiefly explanatory of the Tabular Statements, (which should be studied as containing a careful abstract of all the information collected,) and is no index of the labor bestowed on their preparation

NAINI TAL, 14*th August*, 1882

J CLIBBORN, CAPT, B S C,
Executive Engineer

IRRIGATION FROM WELLS IN NORTH-WEST PROVINCES AND OUDH.

Fig 1



A. Suits kucha wells with Dhenklis
„ Masonry well unsuccessful
B Dry brick or masonry wells.
C Kucha wells unlined.
D Masonry or lined kucha wells
E „ „ „ „
F „ „ „ „
G „ „ „ „

F becomes D in years of heavy rainfall or when canal is opened, and kucha wells suffer, but supply would be increased in masonry wells

Fig 2

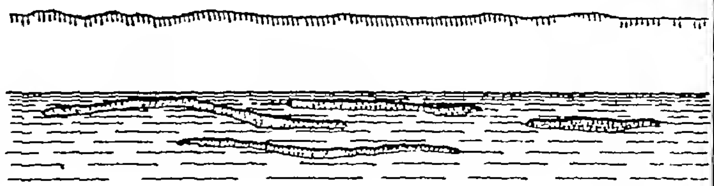


Fig 4

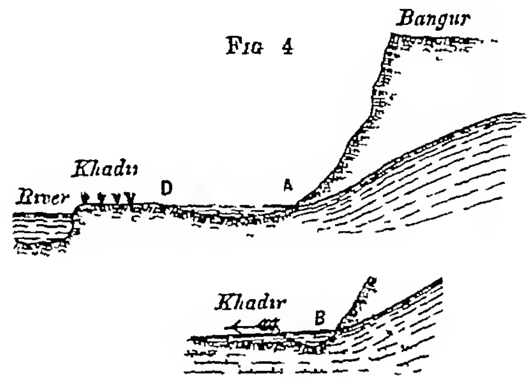


Fig 3

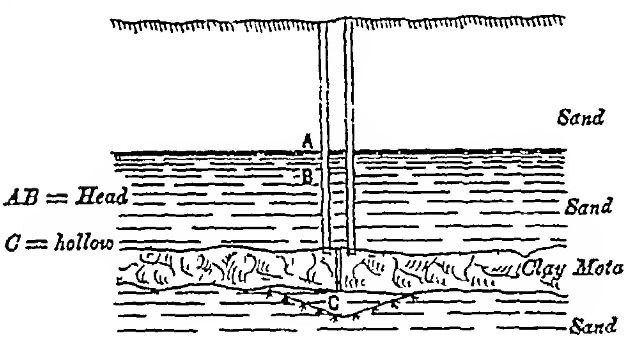


Fig 6

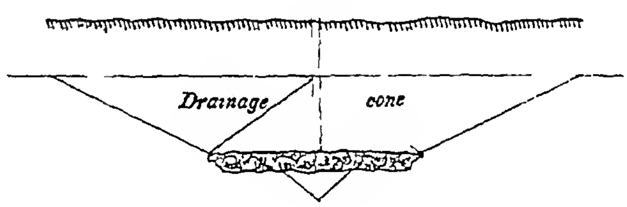


Fig 5

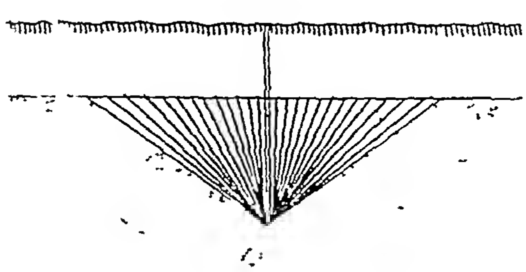


Fig 8

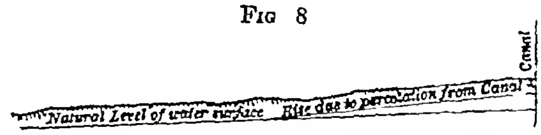


Fig 7

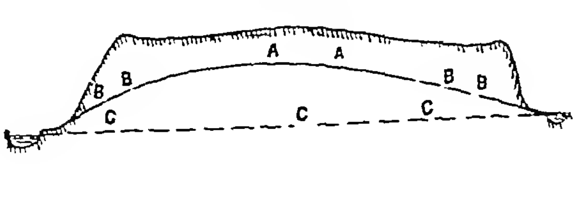
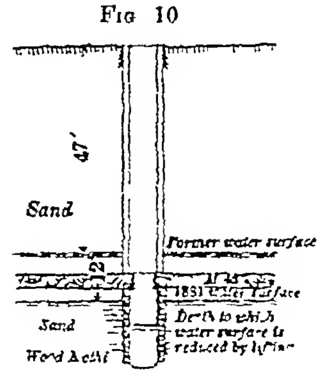


Fig 10



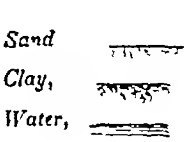
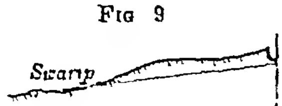


Fig 9



IRRIGATION FROM WELLS IN NORTH-WEST PROVINCES AND OUDH

Fig 11

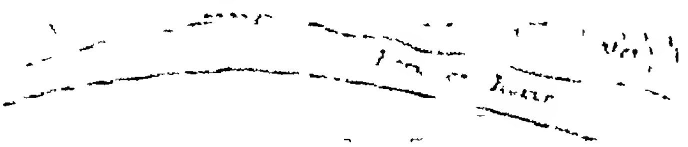


Fig 12

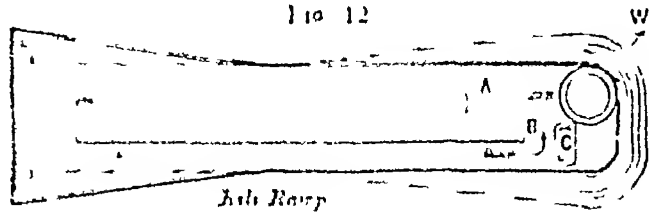


Fig 13

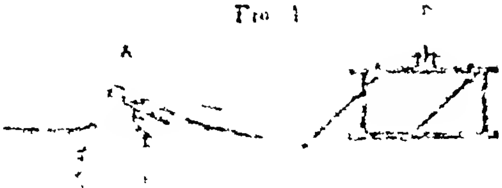


Fig 14

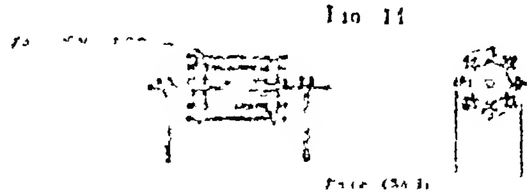


Fig 15

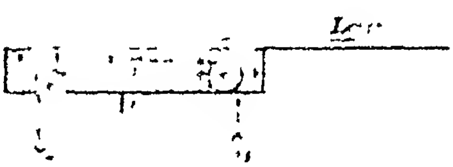


Fig 16

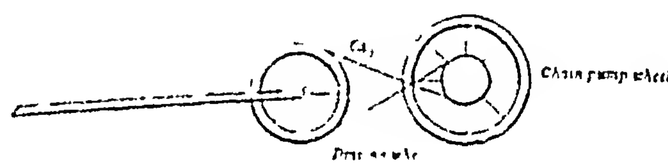


Fig 17

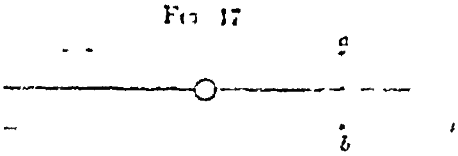


Fig 18

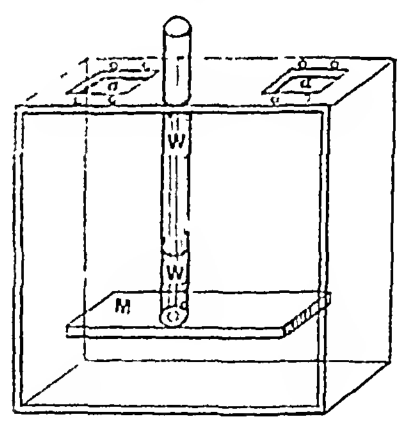


Fig 19

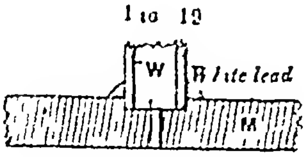


Fig 20

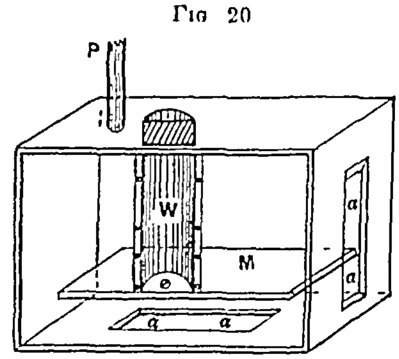
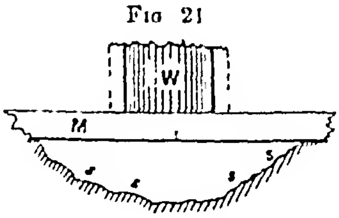


Fig 21

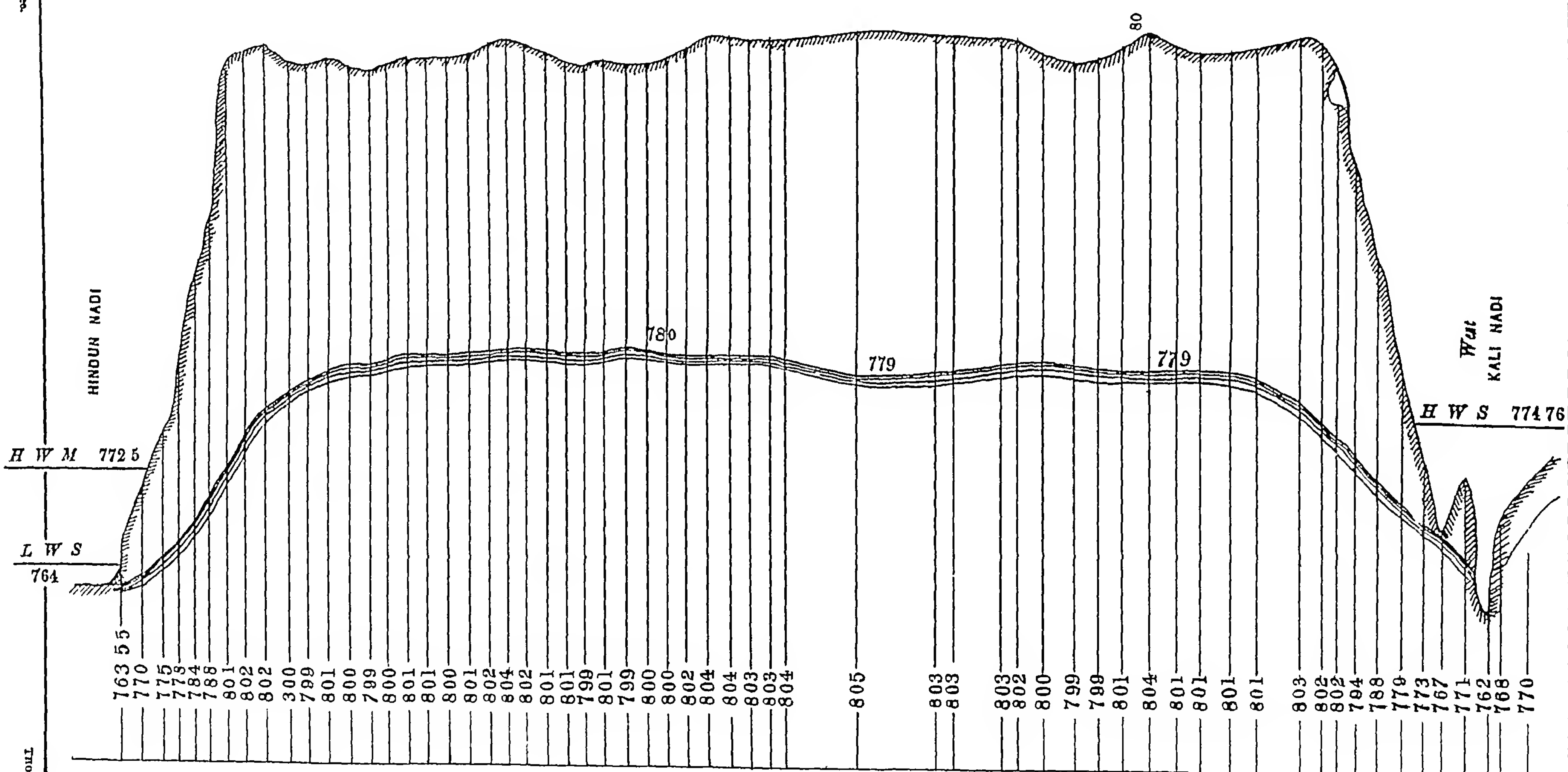


Sand,
Clay,
Water

TION FROM WELLS IN NORTH-WEST PROVINCES AND OUDH

SECTION ALONG SHAMLI ROAD, DEOBAND DOAB, OPPOSITE MUZAFFARNAGAR,

TAKEN 1876.



Horizontal Scale, 1 *Inch to* 1 *Mile*
Vertical „ 10 *Feet to* 1 *Foot*

NOTE

ON THE

CONSTRUCTION OF WELLS ON THE AWA ESTATE.

BY

W. J. WILSON,

EXECUTIVE ENGINEER, DEPARTMENT OF AGRICULTURE AND COMMERCE

NOTE ON THE CONSTRUCTION OF WELLS IN THE AWA ESTATE.

Two parts of the Awa Estate—both in the Etah District—have been selected by Mr Crooke for the purpose of commencing a systematic scheme of well construction One is part of the Jaithra Circle, situated in the Azamnagar Pargana between the Káli Nadi and the Burhganga The other is the Khwájapur Circle, in the Jalesar Pargana between the Domana and Sirsa Nadis The conditions of well construction in the two tracts being very different, I propose to discuss them separately under the following heads —

1 Description of the wells now used
2 The area irrigable from a well
3 The cost of irrigation
4 The construction of masonry wells
5 The cost of masonry wells
6 Report of work done and in progress

JAITHRA CIRCLE

I DESCRIPTION OF THE WELLS NOW USED

2. Two Plates are attached showing the villages in the Jaithra Circle in which wells are being made. *Plate No* I, which is compiled partly from the Aliganj Tahsil Map and partly from a tracing kindly supplied by Major J C Ross, R.E., shows the position of the villages with respect to the Fatehgarh Branch of the Lower Ganges Canal and the Canal Distributaries

A drainage line passes from the village Pachhenda Pahárpur to the north of Dhúmri, through Jaithra and Khiria Lagar Sahai to Targawan, and thence *viâ* Jamlapur into the Káli Nadi The country between the drainage line and the Káli Nadi is partially irrigated by a system of distributaries of the Fatehgarh Branch of the Lower Ganges Canal

The tract between the Targawan drainage line and the Fatehgarh Branch is not to be irrigated from the canal at present, but it is probable that the land between the canal and the large dhák jungle will be ultimately irrigated Throughout this tract the drainage depressions are very marked, but during the rains the drainage lines consist of a series of jhils separated by necks of higher land During heavy rain the water flows along the drainage lines from one depression to another, but after a few days the flow ceases and the jhils remain full The soil is generally *bhur* or light *dúmat* The surface of the ground is uneven, and the rain water collects in numerous small hollows

Owing to these circumstances a large proportion of the rainfall sinks into the ground, and at the end of the rains the depth to the sub-soil water from the surface of the ground is from 6 to 8 feet, except in sand hills and locally high places In the hot months water is usually found from 10 to 12 feet below the surface of the ground, and the villagers say that in a year of drought it falls another 5 or 6 feet

Well irrigation is very general throughout the tract, and helps to lower the level of the sub-soil water in the rabi season The introduction of canal irrigation would reduce the area irrigated from wells, and diminish the quantity of sub-soil water removed by them There is no doubt that the tract has been rightly debarred from canal irrigation

3 In *Plate No* I the debarred tract is colored black, except that part of it which is

included in the Awa Estate, which is colored red The Estate villages are shown on a larger scale in *Plate No* II

The whole of Bahgon, Tigra Bhamora, and Mahaya, about three-fourths of Jaithra, and half of Khirna Lagar Sahai—or about 7,500 acres—are without canal irrigation

4 The land of these villages is divided into two tracts, which may be called—

(i), the spring well tract, and
(ii), the percolation well tract

In the former spring wells are easily made by the villagers It includes a few fields in Jaithra, but is chiefly in Bahgon (*Plate No* II.)

In Jaithra there is one masonry well built by a cultivator, which reaches the spring Another well has been sunk, but the "mota" has not been pierced During last cold weather one kucha spring well was used for irrigation

In Bahgon during the last rabi 6 pucka spring wells, working 14 buckets, and 26 kucha spring wells, working 39 buckets, were used for irrigation

In Khirna Lagar Sahai, Tigra Bhamora, and Mahaya, there are no spring wells

5 The soil sections in the spring wells in Bahgon vary considerably, but as a rule there are from 4 to 9 feet of a sandy loam, called *lelwa*, above the clay In some wells there is no lelwa, clay being found at or above the percolation level In others there are two distinct beds of lelwa separated by a stratum of clay

It is necessary to support the sandy loam by coils of interwoven twigs of arhar, cotton, or dhák, and the villagers say that they cannot make a kucha well if this stratum is more than 9 or 10 feet thick, as the pressure causes the coils of twigs to bulge inwards

The thickness of the mota is said to vary from 6 to 18 feet, but in some places it is so thick that the villagers have been unable to get through it to tap the spring

6 The life of a kucha spring well depends on the nature of the upper soil, the thickness of lelwa and the rainfall It averages from two to three years

The cost of the well depends on the thickness of the bed of lelwa, which must be supported by coils of twigs, and on the thickness of clay, which must be dug in order to get a sufficient supply of water It appears to vary from Rs 3 to 10

Some of the wells give enough water for one, and others for two buckets

7 The pucka spring wells are made of block kankar or bricks set in mud. On one of them four buckets, and on six of them two buckets, are worked

8 In the percolation well tract only two spring wells exist They are in the Jaithra Indigo Factory, and were built some 60 years ago One well, 12 feet in diameter, is said to have cost Rs 1,300, the other, 8 feet in diameter, Rs 850

Figs. 1 and 2, *Plate No* IV are sections of the kucha percolation wells made by the villagers More than three hundred of these wells were used for irrigation during the last rabi season

If the soil is sufficiently firm the well is dug in the form of the frustrum of a cone, 4 to 5 feet wide at the top and 9 feet wide at the percolation level (*Fig* 1) If the soil is too sandy to admit of this, the section shown in *Fig* 2 is adopted, and the trunk of a *khajur* tree is laid across the excavation in order to support the woodwork on which the bucket is worked

A cylinder made of coils of interwoven twigs is sunk from 5 to 6 feet below the percolation level

The cost of making such a well is difficult to ascertain, but the following appears a fair estimate —

	RS	A	P		RS	A	P
Earthwork, ..	0	10	0				
Making 20 to 30 coil of twigs, .	0	10	0	to	0	15	0
Sinking cylinder, 6 to 8 men for 2 days, at Re 0-1-0,	0	12	0		1	0	0
Food for madad, .	1	8	0		2	0	0
Total,	3	8	0	to	4	9	0

The *khâchhis* and other small cultivators club together to make their wells, and no actual cash expenditure is incurred, but the men who have larger holdings employ hired labor

There is a good deal of difference in the wells Those sunk in coarse sand give much more water than those in fine sand The sand that comes into the well is cleared out once or twice a day, and is put on the ledge behind the cylinder So long as a well remains in good order, the older it is the more water it gives

The wells are made as soon as the rabi sowings are completed Last year they were being made as late as the middle of December Irrigation for the earlier sown rabi crops is frequently required before the wells are ready, and the labor now spent in making the kucha wells would be more profitably employed in irrigating from pucka wells

The *Khachhis* take care of their wells and sometimes make them last for two years, but by far the greater number of the percolation wells are used for only one season

9 There are 18 masonry percolation wells in Jaithra, and on three of them two buckets are worked Some are made of kankar, but most are of under-burnt, wedge-shaped bricks set in mud They are 6 to 8 feet in diameter, and have been sunk from 10 to 15 feet below the percolation level They are made only in places where experience with kucha wells has shown the sand to be coarse and to give a good supply of water They require to be cleared out occasionally

Their chief advantage is their durability In a year of drought they give very little water, the cylinders not being deep enough

10 The water lift in general use in these villages is the single bucket with inclined bullock run The cattle are worked on the *nagaur* system, the rope remaining attached to the yoke while the bullocks ascend the run The buckets are small, those which have been measured containing from 14 to 20 gallons Buckets that have been in use for some time, and have been torn and repaired, contain much less than new buckets The cattle are much smaller than those used in the Jalesar pargana

To work one bucket two men are employed, one to drive the bullocks, and the other to fill and empty the bucket When two buckets are worked on a well the bullock runs are parallel to each other on the same side of the well, and one man is able to attend to both buckets, while the second drives the two pair of cattle Hence a considerable saving of manual labor is effected by working two buckets on the same well When four buckets are worked, two are fixed on one side and two on the other side of the well

The *dhenkli* and *râhat*, or *charkhi*, are occasionally used by *khachhis* and small cultivators

II THE AREA IRRIGABLE FROM A WELL

11 Tables I and II give the area irrigated during last rabi by a number of spring and percolation wells in villages of the Jaithra Circle The average results obtained are at first sight rather surprising, the area irrigated per bucket from spring wells being 2 32 acres, while from percolation wells it is 2 82 acres It will be noticed too that the area irrigated from the pucka spring wells was only 1 75 acres per bucket, while from the kucha spring wells it was 2 63 acres

This is due (i), to some of the masonry wells being in a bad state of repair, (ii), to the

area under rabi round some of the wells being insufficient to keep them constantly at work, and (iii), to the cultivated fields being scattered and at a considerable distance from some of the wells There is a good deal of *usar* in the spring well tract, and the water is sometimes taken a distance of one or two furlongs through waste land in order to get to a field to be irrigated.

In the percolation well tract there is not much usar The wells are made after the rabi sowings have been completed, and their positions are chosen with respect to the fields to be irrigated The area round a percolation well is compact, and is more easily irrigated than the scattered fields round a spring well

12 The villagers say that if a well gives enough water one bucket can irrigate 20 kucha bigahs, or about 4 acres, in the rabi season, and this area was attained on some of the single-bucket wells The wells now being made should irrigate 3 acres per bucket, which is very little more than the average obtained from the wells on which irrigation was recorded

13 In estimating the area *irrigable* from a masonry well, it is necessary to consider the system of cultivation adopted in the fields round the well

The *gauhan* lands, which are immediately round a village, often yield two crops a year

The *barha*, or outlying lands, are sown only once a year, and it is customary to alternate kharif and rabi crops An exception must be made, however, in the case of the *tarai*, or low-lying lands, as, owing to their being under water during the rains, no kharif crop except rice can be sown in them, and it is a common practice to sow rabi crops in these fields every year

Manjha lands appear as a rule to be sown only once a year

14 The land of a village may, therefore, be divided into two classes —

A. Fields in which rabi crops are sown every year, comprising the gauhan and tarai

B Fields in which rabi crops are sown every second year, comprising the rest of the village

In fields of class A, the maximum area that can be irrigated from a well is the area that can be irrigated in the rabi season, or 3 acres per bucket. But in fields of class B, the irrigable area is twice the area that can be irrigated in one rabi season, or 6 acres per bucket

It is assumed that the cultivation round a well in the outlying lands is so arranged that half the land is under rabi and half under kharif crops in each year If the whole of the land is under kharif one year and under rabi the next year, half the irrigating power of the well will be lost, as the well will only be worked during every second cold season

15 The irrigation of kharif crops is not taken into account, but it will be seen that this does not affect the result In the gauhan the fields which are irrigated during the hot weather and rains are also irrigated in the rabi season In the outlying lands the fields of juar or bajra that may be irrigated were under rabi during the preceding year, and are included in the irrigable area.

Sugarcane is the only kharif crop that requires watering during the cold weather If any fields round a well are under sugarcane, the area under rabi crops that can be irrigated will be reduced, but the total area irrigable from the well will not be altered

16 The best size of well to build depends on—

(i), the supply obtainable from the well,

(ii), the relative cost of different sizes, and

(iii), the position of the well with respect to the land to be irrigated

Other things being equal, the considerations in para 14 point to the conclusion that larger wells should be built in gauhan and tarai lands than in the outlying lands of a village In the latter a four-bucket well can irrigate 24 acres, while in the former an eight-bucket well is required to irrigate the same area In each case the water must go the same distance,

and there will be the same loss in the water-courses Hence, if a four-bucket well is the best size for the barha lands, an eight-bucket well is the best size for gauhan and tarai lands

III. THE COST OF IRRIGATION

17 It is not necessary to consider the cost of raising the water, as this must be done whatever kind of well is used But it has been noticed in para 10 that considerable economy in manual labor will result from substituting masonry wells working 2, 4 or 8 buckets for the single-bucket wells now used. 318 single-bucket wells were worked last cold weather in the percolation well tract, and two men were required to each bucket. If these wells were replaced by masonry wells, the labor of 318 men would be liberated, and would be available for irrigating the land which is now dry Roughly speaking, the labor of one man for 3 months would be saved for each bucket irrigating 3 acres, or of one man for one month per acre irrigated.

18 The cost of making a kucha percolation well is given in para 8 at Rs 3-8-0 to Rs 4-9-0, but part of this is home labor, and the actual expense to the cultivator is probably about Rs 3 per well, or Re 1 per acre irrigated If the value of the liberated labor is estimated at Re 1 per acre, the total saving to the villagers by using masonry wells is Rs 2 per acre This may be considered a low estimate of the direct gain that will accrue to the cultivator every year from the construction of masonry wells

Other advantages are—

(i) The rabi crops can be irrigated as soon as they require water

(ii) If there is a long break in the rains the kharif crops can be saved

(iii) In a year of drought the villagers will be nearly as well off for water as in a year of average rainfall.

19 If Rs 2 per acre is the cultivator's profit from masonry wells each year his rabi crops are irrigated, this represents his annual profit in the case of gauhan and tarai lands, and his two-yearly profit in outlying lands

I understand that Mr Crooke has fixed 3 annas per kacha bigah, or very nearly Re 1 per acre as the general rate of enhancement in the Jaithra Circle, and the preceding calculations show that the direct profits to the cultivator, owing to his not having to make kucha wells, and to the saving in manual labor, are at least equal to this If the cultivators can pay an enhancement of Re 1 per acre in outlying lands, they can afford to pay Rs 2 per acre in gauhan and tarai lands

20 To sum up for the percolation well tract

One bucket can irrigate 3 acres of rabi crops in a season

Gauhan and tarai lands are usually under rabi crops every year The irrigable area from a masonry well in these lands is 3 acres per bucket

Fields in the barha are generally sown with rabi crops every second year The irrigable area from a well in this land is 6 acres per bucket

Cultivators can afford to pay twice as much enhancement in gauhan and tarai lands as in the outlying lands of a village If the rate for the latter is fixed at Re 1 per acre, for the former it should be Rs 2 per acre

In this case the enhancement on the land round a well will be Rs 6 per bucket for all classes of land

21 I have considered only the cultivator's profit by the substitution of masonry wells for kucha wells But there are places where the soil below the level of the sub-soil water is either lelwa or very fine sand, which yields so little water that percolation wells are not made In other places the soil above the water surface is so sandy that kucha wells are made with difficulty, and are too costly to prove remunerative These lands are now unirrigated, and should bear a higher rate of enhancement than fields in which kucha wells are easily made

If the surface soil is sandy the area irrigable from the well should be reduced from 6 to say 5 acres per bucket in the barha, and from 3 to 2½ acres in the gauhan

22 As regards the spring well tract Kucha wells cost from Rs 3 to Rs 10, and last from two to three years Some give enough water for two buckets, others for only one. The annual cost per bucket appears to vary from Re 1 to Rs 3

Some cultivators have asked to have wells built in this tract, and it may be advisable to make them where the strata of lelra and clay are thickest But it is rarely expedient to construct masonry wells in lands where kucha spring wells are easily made As shown in para 35, conditions which favor the construction of kucha spring wells may prevent a really efficient masonry well being built

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IV THE CONSTRUCTION OF MASONRY WELLS

23 The wells in course of construction at Jaithra are of three kinds—

(i) Spring wells in which the masonry steining rests on clay

(ii) Spring wells in which the masonry cylinder rests on sand, and the supply is obtained through a tube extending from the bottom of the cylinder to the clay

(iii) Percolation wells which are entirely in sand, and the steining of which is made of bricks laid dry, so that water may filter through the joints.

The principles which regulate the construction of each kind of well may be briefly noted

24 *Spring wells in which the masonry steining reaches clay* —These wells obtain their supply from a bed of sand underlying an impermeable stratum below the level of sub-soil water It is not necessary that the impermeable stratum should be continuous over a large area, and instances are common of good springs being obtained by piercing a clay stratum extending over a few bighas

Fig 3, Plate No IV shows a well sunk into clay and obtaining its supply from the sand below As the water in the well is removed, the supply is maintained by water coming in through the hole in the clay At first some sand comes into the well with the water, and it is probable that a basin-shaped reservoir (shown by the dotted line) is formed, of which the clay acts as the roof The size of the reservoir increases until the velocity of the water filtering into it from the sand becomes so small that the sand is not disturbed.

If this explanation of the action in an ordinary spring well is correct, it is evident that so long as the clay stratum is of sufficient extent to allow a reservoir to form beneath it, and is strong enough to support the well above it, a supply of water will be obtained without sand coming into the well

The term " mota " is applied to the stratum of clay, or of clay and kankar, by piercing which a supply of water is obtained In Majhola, a village near Jaithra, there are some wells which rest on a stratum of nodular kankar without clay, and which give sufficient water for two buckets without sand coming in But it is rare that such a stratum is found of sufficient thickness and with the nodules close enough together to form an efficient " mota."

25 An ordinary spring well consists of two parts—

(i), the masonry cylinder, and

(ii), the hole through the clay

The masonry cylinder is simply a cistern in which the buckets work, and its diameter is regulated by the number and size of the buckets The first wells made at Jaithra were 5 feet in diameter and were intended to work two buckets; but it was found that two of the small buckets used there could be worked in a well 4½ feet in diameter, and that a 6 feet well would take four buckets To decide the point four buckets were fitted on a well 6 feet in diameter, and a number of cultivators assembled to see the buckets worked, they decided that the well was large enough

The cylinder must be sunk to such a depth that it will contain sufficient water in a year of drought. When a well is worked, the water in it should not fall more than 10 feet, and if the supply is copious the fall will be much less There should be at least 4 feet of water remaining in the well to allow the buckets to be properly filled Hence the cylinder should be sunk 14 feet below the level of sub-soil water in a dry year The cultivators at Jaithra say that they have never known the water to fall more than 5 or 6 feet below the ordinary hot weather level It should, therefore, be sufficient to sink the wells 20 feet below the average percolation level in the hot season But as the water may fall lower in a year of drought than the cultivators say, it is proposed to sink the cylinders 25 feet

26 The spring is generally tapped by simply piercing the clay But there is sometimes too great a thickness of clay to admit of this, or, after getting through some feet of clay, a stratum of loam, or a thin stratum of sand, may be reached, beneath which lies the true "mota" In these cases it is necessary to sink a small shaft through the upper part of the clay, or through the loam, and to line it with brickwork (*Fig* 4, *Plate No* IV)

27 *Spring tube wells*—In places where the clay stratum is too deep to be reached by the masonry steining, a spring well can be made by sinking a pipe from the bottom of the cylinder to the clay (*Fig* 5, *Plate No* IV)

In order to keep the sand, on which the curb rests, from coming into the cylinder, it is necessary to ram a plug of concrete about 5 feet thick in the bottom of the well between the pipe and the steining To allow for this the cylinder should be sunk 30 feet below the ordinary percolation level

At Moradabad the tubes used in the wells have been made of *gúlar* wood, which is known to be very durable under water At Jaithra all the *gular* trees in the Estate villages have been cut down for making curbs, and there are very few trees available for making the tubes It is proposed, therefore, to use cast-iron tubes with spigot and faucet joints held together by screws They are much more expensive than wooden tubes, but Mr Meares reports that he finds great difficulty in sinking the latter through sandy soil containing nodular kankar In some of the trial borings at Jaithra such a stratum has been found overlying the clay, and it is absolutely necessary to get through it, and to bed the tubes firmly into the clay The cast-iron pipes will go through nodular kankar much more readily than wooden tubes will, and this advantage may more than compensate for their additional cost

This description of well is analogous to the well with the small shaft shown in *Fig* 4 If the main cylinder of the well is bedded in clay, it is generally easy to bale out the water and to dig the shaft, and the masonry lining is nearly as cheap, and is certainly more durable than the iron or wooden pipe But if the cylinder rests in sand, it is much easier to sink a pipe through the sand to the clay than to sink a small masonry shaft The main cylinder of the well might be carried down to the full depth of the small shaft or pipe, but this would be both useless and very expensive.

28 The diameter of the pipe is a most important point to determine

When a spring well is worked, the water level falls until the water enters the well at the rate at which it is withdrawn by the buckets The fall represents the head expended in overcoming the resistance to the flow of the water, (i), through the sand from which the supply is drawn, and (ii), through the well The former resistance varies with the degree of coarseness of the sand The coarser the sand, the more readily will the water flow through it, and the less will be the loss of head The head lost in the well may be calculated by assuming the water to flow from a reservoir below the clay through the tube into the masonry cistern in which the buckets work The velocity in the reservoir below the clay, and in the masonry cistern above the tube, is very small and may be neglected

The hole in the clay in an ordinary well corresponds to the tube in a deep well, and as the diamet - of the hole can easily be made as large as desired, and the length is generally small, the l. s of head in the well is inconsiderable, and the fall of the water when the well

is worked nearly represents the head expended in overcoming the resistance to the flow of water through the sand below the "mota"

But the following calculations show that in a tube well the loss of head caused by using too small a pipe may be very great—

Let v = velocity of water through the tube in feet per second

h = head due to the velocity $= \frac{v^2}{64\ 4}$

l = length of tube in feet

d = diameter of tube in feet

The head lost in the well is expended in three ways—

1 A portion of head, which experiment shows is equal to 0 505 h, is employed in overcoming the resistance at the lower end of the tube

2 A portion, which is equal to h, is wasted in eddying motion in the masonry reservoir at the upper end of the tube.

The loss of head at the two ends of the tube is therefore equal to 1 505 h

3 The head expended in overcoming the friction of the tube is equal to $c \frac{4l}{d} h$, where c is a co-efficient which has been found by experiment

The values of these quantities for pipes 50 and 100 feet in length, and of different diameters, and discharging $\frac{1}{4}$, $\frac{1}{3}$ and $\frac{1}{2}$ cubic foot per second, are given in Table IV

The values of c are those found by Darcy for old and incrusted pipes, and are double the co-efficients for new and clean pipes (Unwin's Hydraulics)

Experiments have shown that the maximum discharge from a 6 feet well worked by bullocks may be taken at 900 cubic feet per hour, or 0 25 cubic foot per second, and from an 8 feet well at 1,800 cubic feet per hour, or 0 5 cubic foot per second These discharges are rarely obtained by the villagers If men are employed to work the buckets, 1,200 cubic feet per hour may be raised from a 6 feet well

It will be seen from the Table that a 3-inch pipe is quite unsuitable for any but the smallest wells With a discharge of 0 25 cubic foot per second, 4 90 feet of head are lost in 50 feet of 3-inch pipe while only 1 15 foot is lost in a 4-inch pipe of the same length, the difference is nearly 4 feet With a discharge of 0 5 cubic foot per second, the head lost in 50 feet of 3-inch pipe is 19 58 feet, and in a 5-inch pipe of the same length it is only 1 51 foot, the difference is 18 feet.

The diameter of the pipe should be regulated by its length, and by the size of the well But it is convenient to have a standard size, and the 5-inch pipe appears most suitable for irrigation wells

With a discharge of 0 5 cubic foot per second, the head lost in 100 feet of 5-inch pipe is 2 71 feet, and in the same length of 6-inch pipe it is 1 09 feet. The difference is 1 62 feet If iron pipes are used, the difference in cost between pipes 6 inches and 5 inches in diameter is probably greater than the cost of sinking the main cylinder of the well an extra 2 feet, which will more than allow for the additional loss of head (1 62 feet) caused by using the smaller pipe

29 *Percolation wells* —*Fig* 6, *Plate No* V, is a section of the percolation wells which it is proposed to build. In the lower 5 feet of the steining the bricks are set in mortar, above this the bricks are laid dry to a height of 4½ feet This is succeeded by 1 foot in which the bricks are laid in mortar, this again by 4½ feet, consisting of bricks laid dry, and so on till the cylinder has reached a height of 26 feet, above which to the top the bricks will be set in mortar The cylinder will be sunk 30 feet and a plug of concrete 5 feet in thickness will be put into it

30 A paper read by Mr Sutcliff before the Society of Engineers in December 1877, describes the systems that have been tried in England in order to obtain a supply of water

from tube wells sunk in sand Those wells, commonly known as the "Abyssinian tube wells," consist of wrought-iron tubes connected by screwed sockets, the lowest tubes being furnished with steel points and perforated with holes varying from ⅛ to ¼ inch in diameter, extending from 15 inches to 3 feet upwards from the points The tubes are driven into the ground until a stratum is reached that will yield water A pump is then attached to the top of the tubes, and on working the pump water is drawn in through the percolations in the lowest tube and is discharged above the surface of the ground When the lowest tube is in a stratum consisting entirely of fine sand it soon becomes choked, and the sand flows in through the perforations as fast as it is cleared out The following extract from Mr Sutcliff's paper, which describes some of the plans that have been adopted to overcome this difficulty, is interesting —

"A tube well was driven at Chislehurst into an extremely fine sand, and it was found impossible with the horse-hair strainer to get any supply of clear water The tubes were withdrawn, and the point screwed off, and the pipe driven in the same hole The pump was then screwed to the top of the tubes, and four or five barrow-loads of sand pumped up Previously to doing this, however, six barrow-loads of good clean sharp grit gravel were brought to the spot The pump was removed, and down the tube, which was only 1¼-inch internal diameter, as much gravel was forced ramrod fashion as filled up the cavity made by the removal of the sand The open tube was then withdrawn and a pointed and perforated tube driven into the gravel bed thus formed A coarse sand tube was dropped into the well to keep back the grit, and upon again attaching the pump the water came freely, and rapidly cleared. *Fig* 7, *Plate No* V shows the bed of gravel inserted in the manner described In consequence of the success of this well another was sunk on the same estate with equally satisfactory results, and these two wells have now been in use over two years, and within the last few weeks a third has been added At Orpington, in Kent, what is known as a blowing sand was dealt with somewhat similarly Owing to the nature of the sand a cavity could not be made in it as in the previous case A hole 6 or 7 inches in diameter was therefore bored and piped down with large tubes, until several feet of the quicksand had been passed through The quicksand was removed from the pipes with an ordinary boring shell, and gravel was rammed down, the large tubes being gradually withdrawn as the work progressed The small 1¼-inch tube was then driven into this vertical gravel bed as shown in *Fig* 8, *Plate No* V, and a good well made, which gave a supply of about 200 gallons per hour Clay was rammed tightly over the gravel to prevent drainage contaminating the well The large tube was entirely dispensed with before completing the work

"Another method of introducing a gravel bed was employed in a dug well at Lewisham in Kent The dug well became dry last summer, and to obtain a fresh supply a tube well was driven below the bottom of it, and water in a fine silver sand obtained Gravel was thrown into the dug well, and by its weight gravitated to the spot from which the sand was being drawn The operation of pumping out the sand and replacing it with gravel was continued until the water became entirely free from sand, and was so plentiful that two pumps were attached to it and the next house supplied from it"

From the description of the system adopted at Orpington, it appears that when the tube was surrounded by a layer of gravel, a discharge of 200 gallons (= 32 cubic feet) per hour was obtained without any sand coming into the well

31 Mr Bull, C E, has built some wells in which all the bricks from the curb to within a few feet of the ground level are laid dry, and it is said that little or no difficulty is experienced from the sand coming in through the joints The character of the sand in different wells varies very much, but there can be no doubt that if the steining of a percolation well can be completely surrounded by a layer of small material, such as broken brick (*Fig* 6, *Plate No* V) the efficiency of the well will be greatly increased

In 1880 two percolation wells were sunk, but they reached clay within 19 feet of the level of sub-soil water The area of the surface through which the water can filter is, therefore, much less than in the wells now under construction The wells gave sufficient water for one bucket without much sand coming in, but when two buckets were worked the

wells rapidly silted up The earth round one of the wells was cleared out and a trench about 3 feet wide was dug round the cylinder to a depth of 1 foot 6 inches below the percolation level Lime siftings and broken brick were thrown into the trench A pump raising almost as much water as two small buckets was worked for a fortnight, when it broke down and was replaced by a smaller pump, which was worked for two months The result was that very little sand came into the well while the material in the trench sank a few inches Had this plan been adopted immediately after the well was built, it is probable that the broken brick would have sunk more rapidly It will be tried on one or two of the new wells, and if the results are not satisfactory, a somewhat similar plan to that described by Mr Sutcliff as having proved successful at Orpington will be adopted

A pipe 6 inches in diameter will be sunk about 6 inches from the steining to a depth of 25 feet. Small brick ballast will be rammed into the pipe and forced into the sand at the bottom The pipe will be withdrawn, and as it rises more broken brick will be rammed into it It will be necessary to sink the pipe in 12 or 15 places at intervals of about 2 feet round the steining In this way the cylinder should be completely surrounded by broken brick to a distance of from 12 to 18 inches, more of the ballast will be filled into a trench round the well

32 The filter beds generally used in waterworks for the supply of towns consist of a layer of gravel covered with a layer of sand, and they are generally designed with an area of one square yard for each 700 gallons (= 112 cubic feet) of water to be filtered in 24 hours This is at the rate of nearly 5 cubic feet per square yard per hour

The steining of a percolation well with the broken brick and sand round it forms a filter bed When the well is worked the water will fall a few feet, say 4 feet, and if the well has been sunk 30 feet below the percolation level, and the concrete plug is 5 feet thick, the length of the cylinder through which the water can filter will be 21 feet If there is a foot of brick ballast all round the steining the area of the outside of the cylinder of broken brick will be

$$21 \times 3\frac{1}{7} \times 10 = 660 \text{ square feet,}$$
$$= 73 \text{ square yards nearly}$$

If the water passes into the broken brick from the sand at the rate generally allowed in filter beds, the quantity obtainable from the well will be

$$73 \times 5 = 365 \text{ cubic feet per hour,}$$

or fully enough to supply two of the buckets used at Jathra

The velocity of flow through a filter bed is kept very low in order to remove all the mechanical impurities and to oxidize the organic impurities present in the water, and it is probable that a much higher velocity may be permitted without drawing sand into the well If a rate of 10 cubic feet per square yard per hour can be attained, the well will give sufficient water for four buckets

33 It remains to consider the effect of a year of drought on these wells By sinking the cylinder of a spring well 30 feet, allowance is made for a fall of the water surface to the extent of 11 feet in a dry year If such a fall occur, the length of cylinder of a percolation well through which the water can filter will be reduced from 21 feet to 10 feet, and a discharge at the rate of 20 cubic feet per square yard per hour will be required to supply four buckets If this rate cannot be attained without bringing sand into the well, either the cylinder must be sunk deeper or the discharge from the well must be reduced.

34 The figures given above show the advantage obtained by making the side of the cylinder permeable to water If the bricks of the steining are laid in mortar the well must obtain its supply entirely from the sand at the bottom By throwing broken brick into the bottom of a 6 feet well, a filter bed, having an area of 3 square yards, will be formed, and at the rate of 5 cubic feet per square yard, the discharge will be 15 cubic feet per hour Even if the rate of discharge can be increased to 20 cubic feet per square yard per second without bringing in sand, the well will not be of much use for irrigation purposes

[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

[illegible]

80 feet below the water level without reaching clay Unless a very cheap description of pipe is used it will rarely pay to build spring wells in places where the "mota" is more than 50 feet deep, and it is in these places that the greatest necessity exists for good percolation wells

V THE COST OF MASONRY WELLS

38 *Spring wells with cylinders resting on clay*—Cylinders 6 feet in diameter are made 1 foot thick. The bricks are made segmental to fit the curve of the well, their mean dimensions being 12" × 6" × 3" Two moulds are used—one for headers, the other for stretchers.

One foot in length of the cylinder contains 22 cubic feet of masonry, and at Rs 20 per 100 cubic feet, costs Rs 4-6-6

The cost of sinking varies very much. Through lelwa, the progress is much slower than through sand. Getting the cylinder into the clay is expensive, and more wells must be sunk before the average rate can be ascertained, but it should not exceed Rs. 3 per foot

The curbs of wells that are sunk into clay are fitted with iron shoes to facilitate the sinking

The depth to the percolation level from the surface of the ground averages about 12 feet.

39 The estimated cost of a well, the cylinder of which is 6 feet in diameter, sunk 25 feet below the percolation level, and built to a height of 2 feet above it, is as follows.—

	RS	A.
Curb, fitted with iron shoe, ...	30	0
Masonry cylinder, 39 feet, at Rs 4-6-6 per foot, ..	171	14
Sinking, 25 feet, at Rs 3 per foot, ...	75	0
Earthwork, ...	10	0
	286	14
Establishment, at Rs. 10 per cent., ...	28	11
Tools and plant, at Rs 5 per cent., ...	14	6
Contingencies, ...	20	1
Total Rs., ..	350	0

If a small shaft, 10 feet in length, is required in the clay, the cost of this must be added The masonry lining may be 3 feet in diameter and 6 inches thick. One foot in length contains 4 5 cubic feet, and costs Re. 0-14-6 The cost will be—

	RS	A
Curb, ...	5	0
Masonry lining of shaft, 10 feet, ...	9	1
Sinking shaft, ...	10	0
	24	1
Add for establishment, tools and plant and contingencies, ..	5	15
Cost of shaft, ..	30	0

Hence the total cost of the well will be Rs. 380

If these small shafts are required in half the wells, the average cost of the spring wells 6 feet in diameter, will be Rs 365

In a previous note on the Jathra wells the average cost of a 5 feet well was estimated

at Rs 250 A 5 feet well will take only 2 buckets, while a 6 feet well will take 4 buckets A four-bucket well at Rs 365 is cheaper than a two-bucket well at Rs 250

40 These wells may be made more cheaply if the cylinder is not sunk so deep, or if its thickness is decreased

The reasons for sinking the cylinders 25 feet have already been given (paras 25 and 35)

The thickness of the steining may probably be reduced to 10 inches without endangering the stability of the well This will effect a saving of about Rs 25

The cylinder is strained most severely while it is being sunk, and if it is strong enough to stand sinking, and is properly bedded in the clay, it is not likely to fail when it is used for irrigation. Some cylinders 8 feet in diameter and 12 inches thick will shortly be sunk, and if they go down safely, the steining of the 6 feet wells will be reduced to 10 inches

41 No 8 feet wells have yet been made at Jaithra, but two sizes of bricks have been burnt for them.

(i). 10 inches long, suitable for cylinders 15 inches thick

(ii) 12 inches long, suitable for cylinders 12 inches thick

One foot in length of an 8 feet cylinder, 15 inches thick, contains 36 8 cubic feet of masonry, and at Rs 20 per 100 cubic feet, costs Rs 7-4-2

The sinking should not cost more than Rs 4 per foot

The estimated cost of an 8 feet well, sunk 25 feet below the percolation level, and built to a height of 14 feet above it, is as follows —

	Rs	A
Curb, fitted with iron shoe, ...	45	0
Masonry cylinder, 39 feet, at Rs 7-4-2 per foot, ...	283	8
Sinking 25 feet, at Rs 4 per foot, ...	100	0
Earthwork, ...	15	0
	443	8
Establishment, at Rs 10 per cent., ...	44	5
Tools and Plant, at Rs 5 per cent., ...	22	3
Contingencies, ...	30	5
	540	0

If a shaft 10 feet deep is sunk in the clay, the additional cost will be almost the same as for a 6 feet well, or Rs 30, and the total cost of the well will be Rs 570

The average cost of the 8 feet wells will be about Rs 555

If the cylinder is made 12 inches thick, a saving of Rs 50 will be effected

42 To compare the cost of a 6 feet well with that of an 8 feet well

A 6 feet well costs from Rs 340 to Rs 365 according as the cylinder is made 10 inches or 12 inches thick.

An 8 feet well costs from Rs 505 to 555 according as the cylinder is made 12 inches or 15 inches thick.

Hence an 8 feet well costs almost exactly half as much again as a 6 feet well, while it will take twice the number of buckets

43 *Spring tube wells*—One of these wells differs from an ordinary spring well in the following details —

(i) The cylinder is 5 feet longer

(ii) It is sunk 5 feet deeper

(iii) There is a plug of concrete, 5 feet thick, in the bottom of the well

(iv) A pipe extends from about 2 feet above the concrete to the clay

The rate for sinking should be less than in the other wells, as sand only or sand with a little nodular kankar is passed through There is no necessity to have the curb shod with iron.

44 The estimated cost of the cylinder of a 6 feet tube well is as follows —

	RS	A.
Curb, ...	18	0
Masonry cylinder, 12 inches thick, 44 feet, at Rs. 4-6-6, ..	193	14
Sinking, 30 feet, at Rs 2 per foot, ...	60	0
Earthwork, ...	10	0
Concrete, 142 cubic feet, at Rs 14 per 100 cubic feet, .	19	14
	301	12
Establishment, at 10 per cent, ...	30	3
Tools and Plant, at 5 per cent, . -- ..	15	2
Contingencies, ...	22	15
Total, ..	370	0

If the cylinder is made 10 inches thick, a saving of Rs 30 will be effected

45 The estimated cost of the cylinder of an 8 feet tube well is given below—

	RS	A.
Curb, ...	30	0
Masonry cylinder, 15 inches thick, 44 feet, at Rs 7-4-2, ..	319	7
Sinking, 30 feet, at Rs 3, ...	90	0
Earthwork, ...	15	0
Concrete, 250 cubic feet, at Rs. 14 per 100 cubic feet, ..	35	0
	489	7
Establishment, at 10 per cent., . ..	48	15
Tools and Plant, at 5 per cent, ...	24	8
Contingencies, ...	27	2
Total, ..	590	0

By making the cylinder 12 inches thick a saving of Rs 60 may be effected

46 To this must be added the cost of the tube, which will vary with the kind of tubes used and the length required. It was originally intended to use "gular" wood pipes, which were obtained at Moradabad for 10 annas per foot

For reasons given in para. 27, it is necessary to use iron pipes at Jaithra The cheapest pipes in the market are cast-iron pipes with spigot and faucet joints turned and bored The prices of these pipes in Bombay, and the cost of carriage to Agra are given below—

	RS A P		RS A. P	
4-inch pipes cost in Bombay	0 12 0	per foot, and carriage to Agra is	0 9 0	per foot
5-inch ,, ,,	1 0 0	,, ,, ,,	0 12 0	,,
6-inch ,, ,,	1 4 0	,, ,, ,,	0 15 0	,,

To this must be added the cost of making holes, screws, &c., which will add about 8 annas per foot to the price The cost of carriage to Jaithra is about 2 annas per foot.

Hence total cost of pipes at Jaithra will be—

	RS A. P	
4-inch pipes, . ..	1 15 0	per foot
5-inch ,, ...	2 6 0	,,
6-inch ,, ...	2 13 0	,,

The objections to this kind of pipe are that the joints project more than an inch beyond the body of the pipe, and the turned and bored surfaces are not long enough to make the joints quite rigid.

It is probable that these pipes can be sunk to a depth of 50 or 60 feet below the bottom of the well without much difficulty For greater depths it may be necessary to use cast-iron pipes connected by wrought-iron covering hoops

As stated in para 28, the 5-inch pipe is the best size for general use

The pipe projects at least 2 feet above the concrete, and should be sunk 8 feet into the clay Hence the length of pipe required is equal to depth of clay below bottom of well + 10 feet

The cost of the pipe, including sinking when clay is at different depths below the bottom of well, is given below The cost of sinking is estimated at Re 0-8-0 per foot

							RS	A	P
Clay	10	feet below	bottom of well,	cost of	pipe,	..	54	0	0
"	20	"	"	"	"	..	82	12	0
"	30	"	"	"	"	..	111	8	0
"	40	"	"	"	"	..	140	4	0
"	50	"	"	"	"	..	169	0	0
"	70	"	"	"	"	..	226	8	0
"	100	"	"	"	"	..	312	12	0

47 The following Table shows the total cost of a spring tube well when the "mota" is at different depths below the percolation level —

Depth from level of sub-soil water to the mota.	Estimated cost of Well.	
	6 feet in diameter	8 feet in diameter
	Rs Rs	Rs Rs
40	394 to 424	584 to 644
50	423 to 453	613 to 673
60	452 to 482	642 to 702
70	480 to 510	670 to 730
80	509 to 539	699 to 759
100	567 to 597	757 to 817
130	653 to 683	843 to 903

48 *Percolation wells*—The cylinders of these wells are made 6 feet in diameter They will cost almost exactly the same as the cylinders of spring tube wells of the same diameter Extra precautions must be taken in sinking them, and this will counterbalance the saving effected by not using mortar in 18 feet of their length Hence the cost of the cylinder (12 inches thick) will be Rs 370

If the cylinder is surrounded by broken bricks to a thickness of 12 inches, 1,000 cubic feet of brick ballast will be required At Jaithra this will cost very little, as there is a quantity of lime siftings and broken brick at the kiln, which is useless for any other purpose But if a number of these wells were made, it would be necessary to burn or purchase the ballast, which would cost about Rs 4 per 100 cubic feet Hence cost of 1,000 cubic feet of ballast would be Rs 40 To this must be added the cost of sinking it round the cylinder

If the ballast sinks sufficiently by simply working the well, the expenditure will be very small Arrangements must be made to keep the trench open and to carry the water raised from the well over the trench The water will be raised from the well by the cultivators and will be used for irrigation As the ballast sinks, more will be thrown into the trench Rs 10 should be sufficient to cover this In this case the total expenditure on ballast and sinking will be Rs. 50

If it is necessary to sink a pipe round the well and to ram the ballast into it while it is being withdrawn, the cost will be about Rs 50 greater The pump must be sunk and lowered in from 12 to 15 places round the cylinder, say 15 The cost of sinking and withdrawing the pipe once, and ramming the ballast into it, will be about Rs 4, and for doing this 15 times the cost will be Rs 60 Hence the total expenditure, including ballast, sinking pipe, &c, will be Rs 100 Therefore the total cost of a percolation well is Rs 420 to 470

As mentioned above, the cost of the percolation wells at Jaithra will be less than this, as there is a considerable quantity of waste material at the kiln, which will be used for ballast. The percolation wells first made were 5 feet in diameter, and it was intended to make them all of this size, as it was not expected that they would give water for more than two buckets But it appears probable that if the cylinder can be entirely surrounded by ballast, the percolation through it will be sufficient for four buckets. Some percolation wells, 6 feet in diameter, have recently been started

49 The conditions which determine the best size of well to build are given in para 16

It has been estimated (para 42) that an ordinary spring well, 8 feet in diameter, costs half as much again as a well 6 feet in diameter The former will take twice as many buckets as the latter, hence the relative cost per bucket of the two wells is as 3 to 4 We have to consider whether the advantage in cost which the larger well possesses is neutralized by the additional loss in the channels in irrigating a larger area

Water is lost in a watercourse in three ways—(i), by soakage into the soil, (ii), by evaporation from the water surface, and (iii), owing to irregularities in the bed, some water is retained in the channel after irrigation has ceased If the channel has a good slope and is properly made (ii) and (iii) are comparatively small, and the chief loss is by percolation, which varies with the kind of soil through which the watercourse runs

It is probable that in a given channel the loss by soakage varies nearly as the wetted surface (= wetted perimeter × length) of the channel If the rate of discharge is doubled the wetted perimeter is increased in a much smaller proportion, and the channel may be made longer without increasing the percentage lost by percolation Hence if all the water raised from a well is sent down one channel and into one field at a time, the proportion lost in the watercourses on an 8 feet well is probably no greater, and may even be less, than that lost on a 6 feet well

Cultivators are well aware of the economy that results from irrigating on this system, and when the land round a well belongs to different men they frequently combine together to do so But this cannot always be counted on, and if the irrigation of three or four fields is carried on together the loss in the channels will be increased, and the area irrigated from the 8 feet well will be less than double the area irrigable from a 6 feet well So long as the area irrigated for bucket on the former exceeds three-fourths of that on the latter, the advantage as regards economy is still on the side of the 8 feet well

A two-bucket well costs about Rs 250, and the cost per bucket is about 30 per cent. greater than that of a four-bucket well

Until a well is made the water supply obtainable from it is uncertain It varies with the nature of the sand below the "mota," coarse sand yielding water more readily than fine sand It also depends on the extent of the sandy stratum both horizontally and vertically

This uncertainty about the supply is the chief objection to making large wells, as after they are made it may be found that the full number of buckets cannot be worked on them The supply in a spring well is nearly always enough for four, but is frequently insufficient for eight small buckets The former therefore appears the best size for general use

Some 8 feet wells are being built in gauhan land near other wells, in which the supply has proved to be ample

50 As regards spring tube wells Mr Crooke is of opinion that if he can secure a rate of profit at 6 per cent. it will pay him to make wells Allowing, as in the last para, a profit of Rs 24 from a 6 feet well in outlying lands, and of Rs 48 from an 8 feet well in the gauhan and tarai, the cost of a 6 feet well must not exceed Rs 400, and of an 8 feet well Rs 800 The Table in para 47 shows that, accepting these limits, a 6 feet well should not be made where the "mota" is more than 40 feet, nor an 8 feet well where the "mota" is more than 100 feet below the level of sub-soil water

51 Next as to percolation wells Spring tube wells 6 feet in diameter cost Rs 394 to Rs 424 where the "mota" is 40 feet deep, and Rs 423 to Rs 453 where the "mota" is 50 feet deep If a percolation well giving enough water for four buckets in a year of drought can be made for Rs 400, it should be made wherever the "mota" is more than 40 feet deep in preference to a spring tube well 6 feet in diameter

52 Wells of any description can be built more cheaply in a year of drought than after a year of average rainfall If the level of sub-soil water falls 10 feet, the saving in wells of different kinds and sizes will vary from Rs 30 to 50.

VI. REPORT OF WORK DONE AND IN PROGRESS

53 Two experimental wells were sunk at Jaithra in 1880, in sites chosen by Mr Benson One of them reached clay at a depth of 18 feet 6 inches The other was sunk 15 feet 6 inches, and the divers said it was on clay, but this was afterwards found to be incorrect, and the well has been sunk 2 feet 6 inches deeper, and is now on the "mota"

54 In April 1881, a trial boring was made in a spot about three-quarters of a mile from these wells, and clay was found at a depth of 24 feet The boring apparatus used was of the ordinary kind, consisting of iron rods screwed together, with various tools to be attached to the lowest rod The soil being sandy, a 3-inch wrought-iron pipe was sunk to keep the bore open, and the tools worked inside the tube The apparatus proved quite unsuitable for the sandy soil at Jaithra. Each time the tools were withdrawn from the pipe a considerable time was wasted in unscrewing the rods, and only about 1 foot in length of the auger contained sand

The sand came into the pipe almost as quickly as it was removed The trial boring occupied three weeks, and cost Rs 26 in labor alone

55 The two experimental wells made in 1880 are percolation wells, the greater part of the steining below the water surface being made of bricks laid dry This description of well cannot be sunk into or through clay without great difficulty Clay having been found within 24 feet of the percolation level in the three places where trials had been made, the wells, which were then started, were made of bricks laid in mortar Before the end of October, 18 wells had been built and four of them had been sunk 30 feet without reaching clay Since then the remaining 14 wells have been sunk, but only six of them have reached clay

56 The variation in the depth to the clay in different parts of the village rendered it necessary to make a more extensive series of trial borings before building any more wells Some new tools and pipes were ordered in November 1881 They were received in March, but some alterations were required, and these were not completed till May

In the meantime 20 more wells were started, the cylinders being built to a height of only 5 feet pending the results of the trial borings A reference to *Figs* 3 to 6, *Plate No.* IV and V, will show that up to this height the steining of a spring and percolation well is built in exactly the same way, but above 5 feet the bricks in the former are laid in mortar, while in the latter they are laid dry

Bricks were also carried to the sites of 16 wells, and 7 of these have since been started

57 The new boring apparatus is made on the system which has been found to work satisfactorily at Moradabad in sinking the wooden tubes through sand For working in

wet sand a sludge pump is used, very similar in construction to that of a common suction pump It consists of a cylinder with a valve at the bottom opening upwards A piston with a valve in it, also opening upwards, moves up and down inside the cylinder, and a rope is attached to the end of the piston rod The piston is made sufficiently heavy to sink by its own weight When the piston is raised the foot valve of the cylinder opens, and sand and water are drawn into the cylinder When the piston descends the foot valve closes, so that the sand cannot escape, while the valve in the piston opens, allowing the water to pass out The piston is raised and lowered three or four times, in order to fill the pump with sand, the pump is then withdrawn and the sand cleared out If the soil is hard it is first broken by means of a heavy jumper attached to the rope, and the *debris* is removed by the sludge pump This system of boring has been used by Messrs Mather and Platt, of Manchester, in sinking artesian wells to depths of over 1,500 feet, and the deep boring at Umballa was made with their apparatus It is especially useful for boring in wet sand, as the sludge pump is filled very quickly and removed at once by means of the rope, the heavy iron rods being entirely dispensed with Two pumps should be used, one being worked while the other is being cleaned As far as I have seen at present the system does not appear very suitable for getting through soft plastic clay, as the jumper works it up into "puddle," which cannot be removed by the sand pump, But if coarse sand is thrown down the bore before the jumper is worked, the clay is mixed with the sand, and lumps of the mixture are drawn into the pump

58 In May, immediately after the receipt of the new tools, borings were made in two of the wells that had been sunk without reaching clay In one well (in Jaithra) the mota was reached at a depth of 60 feet below the percolation level In the second well (in Khurra Lagar Sahal) the pipes were sunk 75 feet without reaching clay, and as their total length is only 75 feet 6 inches, they could not go any deeper They were therefore withdrawn

59, Since then borings have been made in the 20 wells that were built 5 feet high and in nine more sites The object being to ascertain whether a spring or a percolation well should be made, only 40 feet of tubing are used * If the pipes reach clay they are sunk into it until no sand is brought up in the sludge pump, and the jumper is then worked until it has penetrated 2 or 3 feet of the clay If the clay prove to be thicker than this the pipes are withdrawn If no clay is found, or only a thin stratum which cannot form an efficient "mota," the pipes are sunk 39 feet and then withdrawn

In 22 out of the 29 borings clay has been reached within 25 feet from the percolation level, and at an average depth of 21 feet 3 inches In the remaining seven the pipes were sunk to an average depth of 39 feet 1 inch below the percolation level without finding clay Most of this work has been done since the rains commenced, and the percolation level has risen. The depth, therefore, from the normal percolation level to the clay is less than that given

The 29 borings have cost Rs 76 for labor alone, or Rs 2-10 per boring To this must be added the cost of ropes and an allowance for the wear and tear of tools and pipes. This should not exceed Rs 2, making the total cost of a boring less than Rs 5

60 The result of the trial borings has been to show that in a great part of the tract where kucha percolation wells are now made by the cultivators a stratum of "mota" exists at a depth very favorable for the construction of masonry spring wells This is shown in *Plate No* II Up to the present "mota" has not been found in Khurra Lagar Sahai and Mahaya It is found on the west side of Tigra Bhamora, and in about half of the land of Jaithra which is debarred from canal irrigation In Bahgon it is found on both sides of the tract in which spring wells are made by the villagers Borings are still in progress, and the map will require modification when their results are known

It is interesting to note that the "mota" has been found either within 25 feet from

* *Vide* para 51

the percolation level, or not within 40 feet from it It would appear, therefore, that the stratum which exists under a great part of the percolation well tract terminates abruptly The sections obtained in three wells at *p*, *q* and *r*, are given in *Figs* 9 to 11, *Plate No* V The distance from *p* to *r* is only $2\frac{1}{2}$ furlongs, but the three sections differ very much

Since the borings have been made, work has been started again on the 20 wells that were built to a height of 5 feet, and 7 more wells have been started Seven of these will be percolation wells, and the cylinders of twenty will reach clay

61 Some new tools and pipes have been obtained for making deep borings in the 12 wells which have been sunk One set of pipes, 120 feet long and 3-inch bore, was supplied by the Superintendent of the Canal Foundry, Roorkee, the other, 150 feet long and 2-inch bore, by Messrs T E Thomson and Co of Calcutta The pipes are connected by outside screwed couplings, rounded or bevelled, in order to reduce the resistance as much as possible With each set of pipes three steel shoes have been supplied, so that six smaller sets can be made up, each long enough to ascertain if the "mota" is less than 40 feet from the percolation level or not The sand pumps have been made by Messrs Coen and Co of Agra.

Borings were commenced with these pipes early this month The 3-inch pipes were put down one of the old wells in Jaithra, and reached clay at a depth of 55 feet below the percolation level It was intended to ascertain the thickness of the "mota" by putting an Abyssinian tube well, $1\frac{1}{4}$-inch in diameter, down the 3-inch pipe and trying to drive it through the clay But before the 3-inch pipes were properly bedded in the clay, a jumper got jammed in the lowest pipe, and as the rope broke it was necessary to withdraw the pipes

They were then put down the well in Khiria Lagar Sahai, in which the old pipes had been sunk to a depth of 75 feet without finding clay They have been sunk 80 feet below the percolation level and are still in sand

The 2-inch pipes have been put down a well in Jaithra near the boundary of Khiria Lagar Sahai, and have been sunk 83 feet below the percolation level without reaching clay

Thin seams of soft white clay have been passed through in all the deeper borings that have been made, but they offer little resistance to the passage of the tubes, and would certainly not form a good "mota" Strata of sand kankar and of nodular kankar have also been passed through When the 2-inch pipes were sunk 45 feet below the percolation level, they went through a stratum of kankar, which was so compact that all the water was pumped out of the pipe without drawing any sand into it If the kankar has a sufficient area to allow the cavity mentioned in para 24 to form below it, a good supply of water should be obtained The sinking of the pipes has been continued below this stratum in order to ascertain the depth to the clay

62 The present state of the work is as follows —18 wells have been built and sunk, and six have reached clay Two of the latter are in Jaithra and have been completed, the "mota" having been pierced, they are 6 feet in diameter The remaining four are in Bahgon, and are 5 feet in diameter They would have been finished before this but the gang of divers who sank them proved quite useless as soon as the wells reached clay, though they sank them through the sand without difficulty The divers at Khwâjapur will shortly have finished their work and will be sent to Bahgon

Of the 12 wells that are in sand, five are 5 feet and seven are 6 feet in diameter Borings have been made in three of the latter, and in two of them clay has been reached within 60 feet from the percolation level, while in the third the pipes have been sunk 80 feet without reaching clay A pipe has been sunk 83 feet in one of the 5 feet wells without finding clay

Judging from the positions of the wells, it is probable that clay will be found within 60 feet in five out of the seven 6 feet wells, but no idea can yet be formed of its depth in two of the 6 feet wells and in the five 5 feet wells Owing to the clay stratum being so much deeper than was anticipated, the cost of these wells will be greater than was esti-

mated, but will be advisable to sink iron pipes 5 inches in diameter in all of the 6 feet wells Pipes have been ordered for the two wells in which clay has been found

As regards the 5 feet wells, only two buckets can work in them, and it is not worth while to spend much money on them Unless clay or a compact layer of kankar is found within 20 or 30 feet from the bottom of a 5 feet well, an attempt will be made to get the water by percolation, and it is possible that sufficient water to supply two buckets can be obtained in this way

63 The cylinders of 27 wells are being built, and 8 of them have been partially sunk. 20 cylinders will reach clay, 7 will be sunk 30 feet in sand, and will obtain their water by percolation They cannot be sunk until the masonry is set.

64 Bricks have been carried to the sites of 12 more wells, and as soon as trial borings have been made the wells will be started Until the tube and percolation wells that have been commenced have been finished and tested, it is proposed to confine the work to places where ordinary spring wells can be made.

The financial year of the Awa Estate closed at the end of last month, but the accounts have not yet been made up

KHWAJAPUR CIRCLE.

I DESCRIPTION OF THE WELLS NOW USED

65 The villages of the Khwájapur Circle are shown in *Plate No* III As previously stated, they are situated between the Sirsa and Domaria Nadis The soil is generally light *píliya* or *bhúr* A line of sand-hills runs through the villages, and much of the land is undulating There is very little *usar*

66 Among the sources of irrigation are the Patna jhil and the Sirsa nadi. Khwája-pur is situated on the western border of the Patna jhil, and contains some of its tarai About 200 acres of the village are assessed as irrigated from the jhil

Shamspur is bounded on the south-west by the Sirsa nadi. There is some tarai in the village, and 13 acres are assessed as irrigated from the nadi.

67 Some irrigation is done from two distributaries of the Ganges Canal. The Harduaganj Distributary passes through a corner of Chirgawan, and tails into the Sirsa nadi above Shamspur It irrigates a few fields in both of these villages

The Lodhipur Distributary passes to the east of the villages, and irrigates a few acres in Khwájapur A great part of the land in the Circle is too high to get irrigation from these rajbahas

68 Wells form the main source of irrigation in all the villages, in Ataullahpur, Muhabatpur and Pasyapur Begampur they are the only source The depth from the surface of the ground to the level of sub-soil water varies from 15 to 30 feet The water is generally sweet, but there are some brackish wells in Chirgawan.

A few of the wells receive their supply by side percolation, but most of them reach the "mota," and are supplied by springs

The cost of a kucha well is stated by the villagers to be from Rs. 10 to Rs 12, but from enquiries that have been made the actual cost to the cultivators appears to be about Rs 6

The kucha wells last two years at the furthest, most of them fall in the year they are dug.

None of them give water for more than one bucket, and in some wells the supply is not enough for this

69 All the wells are worked on the *kíli* system, two pairs of bullocks being employed to one bucket. The rope is attached to a loop on the yoke by means of a wooden pin (*kíl*) When the bullocks get to the bottom of the run, the driver removes the pin and walks up the run holding the end of the rope On reaching the top he finds a second pair of bullocks waiting there, and attaches the rope to their yoke By the time the second pair of bullocks have got to the bottom of the run, the first pair have reached the top and are ready to go down again

The buckets are large, containing from 26 to 36 gallons. The cattle are stronger than those used in the eastern part of the Etah District.

70 The following Table, taken from the Settlement papers, gives the areas of irrigated and dry land in six of the villages —

Name of Village	Area of Irrigated land	Area of Dry land	Total cultivated area	Total area.
	acres	acres	acres	acres
Ataullahpur, ...	125	67	192	210
Chirgawan, ...	1,022	183	1,205	1,297
Pasiyapur Begampur, .. .	251	130	381	451
Shamspur, ...	440	594	1,034	1,285
Khwájapur, ...	507	134	641	764
Zainpura, . ..	260	285	545	604
	2,605	1,393	3,998	4,611

Rather more than a third of the cultivated land was assessed as dry

In his note on Zainpura, Mr MacConaghey states that "this estate is capable of much improvement if more cultivators were located and a few pucka wells sunk" The same may be said of other villages—especially Shamspur and Ataullahpur

II. THE AREA IRRIGABLE FROM A WELL

71 Table III. gives the area irrigated during the last rabi from some spring wells in the Khwájapur Circle The average area irrigated per bucket was 7 57 acres from pucka and 5 85 acres from kucha wells, the average for the whole being 6 15 acres

The villagers say that a pair of bullocks can irrigate 25 kucha bigahs, or nearly 5 acres of rabi crops Hence one bucket worked by two pairs of bullocks should irrigate nearly 10 acres Doubtless this area can be irrigated if the well is constantly worked, but the greatest area recorded on a single bucket well is 8 8 acres

The average area irrigated from nine single-bucket pucka wells was 8 11 acres, and from three two-bucket wells it was 6 75 acres per bucket

8 5 acres appears a fair estimate of the area that can be irrigated from a single-bucket well in the rabi season, and a two-bucket well should irrigate 7 5 acres per bucket, or 15 acres altogether

72 The arguments used in paras 14 to 16 when discussing the area irrigable from a well at Jaithra apply equally to the Khwájapur villages A 6 feet well can take two large buckets, and should irrigate 15 acres of land in the rabi season The total area irrigable from a well of this size is 15 acres if the well is situated in gauhan or tarai land, and 30 acres if it is in the barha.

In outlying lands the two-bucket well seems the best size to build, but in the gauhan and tarai lands a four-bucket well, 8 feet in diameter, will prove the most economical, provided the spring is powerful enough to supply it

73 It is interesting to note the difference between the area irrigable from a 6 feet well at Jaithra and from a well of the same size at Khwájapur

At Jaithra the *nágaur* system of working is adopted The cattle and buckets are small Four buckets can be worked in a 6 feet well One bucket irrigates 3 acres of rabi crops, and the well can irrigate 12 acres in a season

At Khwájapur the *kili* system prevails The cattle are stronger and the buckets very large Only two buckets can be worked in a 6 feet well, but one bucket worked by two pairs of bullocks can irrigate 7½ acres in the rabi season. 15 acres can be irrigated from the well, or 25 per cent. more than can be irrigated from a well of the same size at Jaithra

III THE COST OF IRRIGATION.

74 The actual cost to the cultivators of making a kucha well is about Rs 6 The area irrigated by a well in the rabi is rather less than 6 acres (Table III) Most of the wells last only one year Hence the cost of the well is about Re 1 per acre irrigated In gauhan and tarai lands the cost is Re 1 per annum, in outlying lands it is 8 annas per annum.

In order to obtain a fair rate of profit from masonry wells, an enhancement equal to double these rates must be levied on the irrigable area Therefore if pucka wells are built in places where kucha wells can be made, the cultivators must pay for the indirect advantages that will accrue from the wells, in addition to the direct gain they will receive by being saved the cost of making the kucha wells (para 18)

Many of the sites chosen are in places where kucha wells are not made, and then the question to be settled is simply the difference between the value of "wet" and "dry" land.

IV. THE CONSTRUCTION OF MASONRY WELLS.

75 The "mota" appears to be very generally found in sinking wells in the Khwájapur villages, and it is probable that no percolation wells will be required Most of the wells will be ordinary spring wells (*Fig 3, Plate No* IV), but in some places the "mota" may prove sufficiently thick to require a small shaft being sunk into it (*Fig* 4, *Plate No.* IV) A few tube wells (*Fig* 5, *Plate No* IV) may also be required.

76 The principles that regulate the construction of spring wells have already been discussed, One point, however, which has been mentioned in para 35, threatens to assume more importance at Khwájapur than it does at Jaithra Where the strata permit it the cisterns should be 25 feet deep But if the bottom of the "mota" is less than 30 feet below the percolation level, the depth of the cistern must be reduced It is necessary to fix the minimum depth of cistern that may be allowed

As mentioned in para 35 a great deal of uncertainty exists as to the depth the water will fall in a year of drought, and also as to the fall when the well is worked By sinking the cylinder 25 feet below the ordinary percolation level, we allow for a fall of 21 feet when the well is worked during a dry year If the cylinder is sunk only 15 feet, the water cannot fall more than 11 feet altogether, and this is the least amount of fall that should be counted on in a two-bucket well Therefore no 6 feet wells should be built in places where the bottom of the "mota" is less than 20 feet below the percolation level If any masonry wells are made in such places they should be 3 feet 6 inches or 4 feet in diameter, suitable for only one bucket

No 8 feet wells should be built in places where the bottom of the "mota" is less than 30 feet below the percolation level, as the fall of water when four buckets are worked will be greater than when only two are employed

I may mention that an experiment was started at Jaithra to determine the connexion between the discharge from a well and the fall of the water surface, but it was stopped by the early rain The experiment will be made during the cold weather

77 No borings have yet been made in these villages The tools used at Jaithra are designed to work in sandy soil, and if the pipes are not stopped by kankar, lelwa, or clay, they are often sunk 25 feet in a day But when the pipes reach clay the progress is very slow

An Abyssinian tube well, with the driving apparatus used by the Royal Engineers, has been obtained from the Canal Foundry, Roorkee, but it has not yet been tried It is probable that this tube, or a modification of it, will prove very useful for testing clay soils

V THE COST OF MASONRY WELLS

78 In estimating the cost of the wells at Jaithra, the average length of the cylinder

above the percolation level has been assumed to be 14 feet. At Khwájapur it will be about 24 feet, or 10 feet longer

If the cylinders are sunk to the same depth, the cost of the wells at Khwajapur may be found by adding to the estimated cost of the wells at Jaithra the cost of the additional 10 feet of masonry and of the extra earthwork required.

If the cylinder is 6 feet in diameter and 12 inches thick, the cost of 10 feet in length is—

	Rs
10 × Rs 4-6-6 = ...	44
Add for earthwork, establishment, &c., . ..	16
Total Rs, ..	60

By making the cylinder 10 inches thick, the cost will be reduced to Rs 50

If the cylinder is 8 feet in diameter and 15 inches thick, the cost of 10 feet in length will be—

	Rs
10 × Rs 7-4-2 = ...	73
Add for earthwork, establishment, &c, ...	22
Total Rs., ..	95

If the steining is made 12 inches thick, the cost will be reduced to Rs 80

79 Adding these amounts to the figures given in para 42, we obtain the following results —

A 6 feet well costs from Rs 390 to Rs. 425 according as the cylinder is 10 or 12 inches thick

An 8 feet well costs from Rs 585 to Rs. 650 according as the cylinder is 12 or 15 inches thick.

As in the case of the Jaithra wells, the cost of on 8 feet well is about half as much again as the cost of a 6 feet well

80 A 6 feet well in the barha can irrigate 30 acres and if the enhancement is fixed at Re 1 per acre, an annual profit of Rs 30 will be obtained from the well If the well costs Rs 425, the rate of profit will be 7 per cent

An 8 feet well in ganhan land irrigates 30 acres, and if the enhancement on the land is fixed at Rs 2 per acre, an annual profit of Rs 60 will be obtained If the well costs Rs 655, the rate of profit will be 9 2 per cent

81 The cost of a spring tube well may be found by adding the cost of the extra 10 feet of the cylinder to the figures given in para 47

If the minimum rate of profit is fixed at 6 per cent., the cost of a 6 feet well must not exceed Rs 500, and of an 8 feet well Rs 1,000

VI. REPORT OF WORK DONE AND IN PROGRESS

82 Two 6 feet wells have been completed One of them was sunk 22 feet and the other 17 feet when the "mota" was pierced There are about 4 feet of clay below the curbs

Two 6 feet wells have been partially sunk. One cylinder, 7 feet 6 inches in diameter and 12 inches thick, has been built to a height of 30 feet, but has not been sunk. Six curbs of this size have been made, but the cylinders are hardly large enough for four large buckets, so the curbs are now being made 8 feet in diameter

Twenty-five wells have been dug to the percolation level, and all of them would have been started had not the brick-burning failed Two contractors agreed to supply 5,00,000

bricks before the 31st May, at Rs 12 per 1,000 for first class, and Rs 8 per 1,000 for second class bricks For bricks supplied after this date, the rates were to be reduced by Re 1 per 1,000 for each class of bricks Not more than 25 per cent of the total bricks supplied were to be second class The mean dimensions of the bricks is 12″ × 6″ × 3″ The contractors moulded 5,00,000 and burnt 3,00,000, but by far the greater number of the latter have turned out *pila*, and out of the bricks intended for 6 feet cylinders, only enough to build four wells were obtained Most of these are second class, and the wells have therefore been plastered inside

Arrangements have been made to burn the bricks in Bull's kiln by petty contract and daily labor, and some wood on the canal has been purchased for the purpose As soon as the bricks are ready more wells will be commenced

W J WILSON,

14th October, 1882. *Assistant Engineer on Special Duty*

TABLE I.—*Showing area irrigated from Spring Wells in some villages of the Jaithra Circle, Awa Estate, Fasl Rabi*, 1881-82

Description of Well.			Name of village.	Number of wells	Number of buckets	Area irrigated in acres.	Average area irrigated	
Pucka or Kucha.	Number of buckets worked on each well.	Depth from ground to water in well.					By one well.	By one bucket.
		Feet						
Pucka, ..	4	11 and 17	Bahgon, ..	2	8	14 35	7 18	1 79
" .	4	12	Jaithra, ..	1	4	5·29	5 29	1 32
				3	12	19 64	6 55	1 64
"	2	7 and 17	Bahgon, ..	5	10	18 93	3 78	1 89
		Total	Pucka wells, ..	..	22	38 57	..	1 75
Kucha, .	2	10 and 14	Bahgon, ..	14	28	72 07	5 15	2 57
" ..	1	10 and 11	Bahgon, .	11	11	31 24	2 84	2 84
" ..	1	12	Jaithra, ..	1	1	1 94	1 94	1 94
				12	12	33 18	2 77	2 77
		Total	Kucha wells, ..	.	40	105 25	..	2 63
			Grand Total, ..		62	143 82		2 32

TABLE II.—*Showing area irrigated from Percolation Wells in some villages of the Jaithra Circle, Awa Estate, Fasl Rabi*, 1881-82

Description of Well.			Name of village.	Number of wells	Number of buckets.	Area irrigated in acres.	Average area irrigated	
Pucka or Kucha.	Number of buckets worked on each well.	Depth from ground to water in well.					By one well.	By one bucket.
		Feet.						
Pucka, ..	2	10 and 15	Jaithra, ..	3	6	16 15	5 38	2 69
" ..	1	9 and 11	"	15	15	54 10	3 61	3 61
" ..	1	13	Khuria Lagar Sahai	1	1	1 23	1 23	1·23
				16	16	55 33	3 46	3 46
			Total Pucka wells, .		22	71 48	..	3·24
Kucha, ..	2	13	Jaithra, .	1	2	2 05	2 05	1 02
" .	2	11	Mahava, .	1	2	4 76	4 76	2 38
" .	2	10 and 12	Khuria Lagar Sahai,	4	8	13 98	3 49	1·75
" ..	2	13	Tigra Bhamora, .	2	4	15 15	7 57	3 79
				8	16	35·94	4 49	2 24
Kucha, ..	1	1 and 18	Jaithra,	216	216	600 79	2 78	2 78
" ..	1	10 and 18	Khuria Lagar Sahai.	36	36	82 92	2 30	2 30
" .	1	10 and 11	Mahava,	16	16	54 19	3·38	3 38
" ..	1	9 and 11	Bahgon, .	36	36	116 26	3 23	3·23
" ..	1	10 and 11	Tigra Bhamora, ..	14	14	42 48	3 03	3·03
				318	318	896 64	2 82	2·82
			Total Kucha wells, .		334	932 58	.	2 79
			Grand Total, .	..	356	1,004 06	.	2·82

TABLE III —*Showing area irrigated from Spring Wells in some villages of the Khwájapur Circle, Awa Estate Fasl Rabi* 1881-82

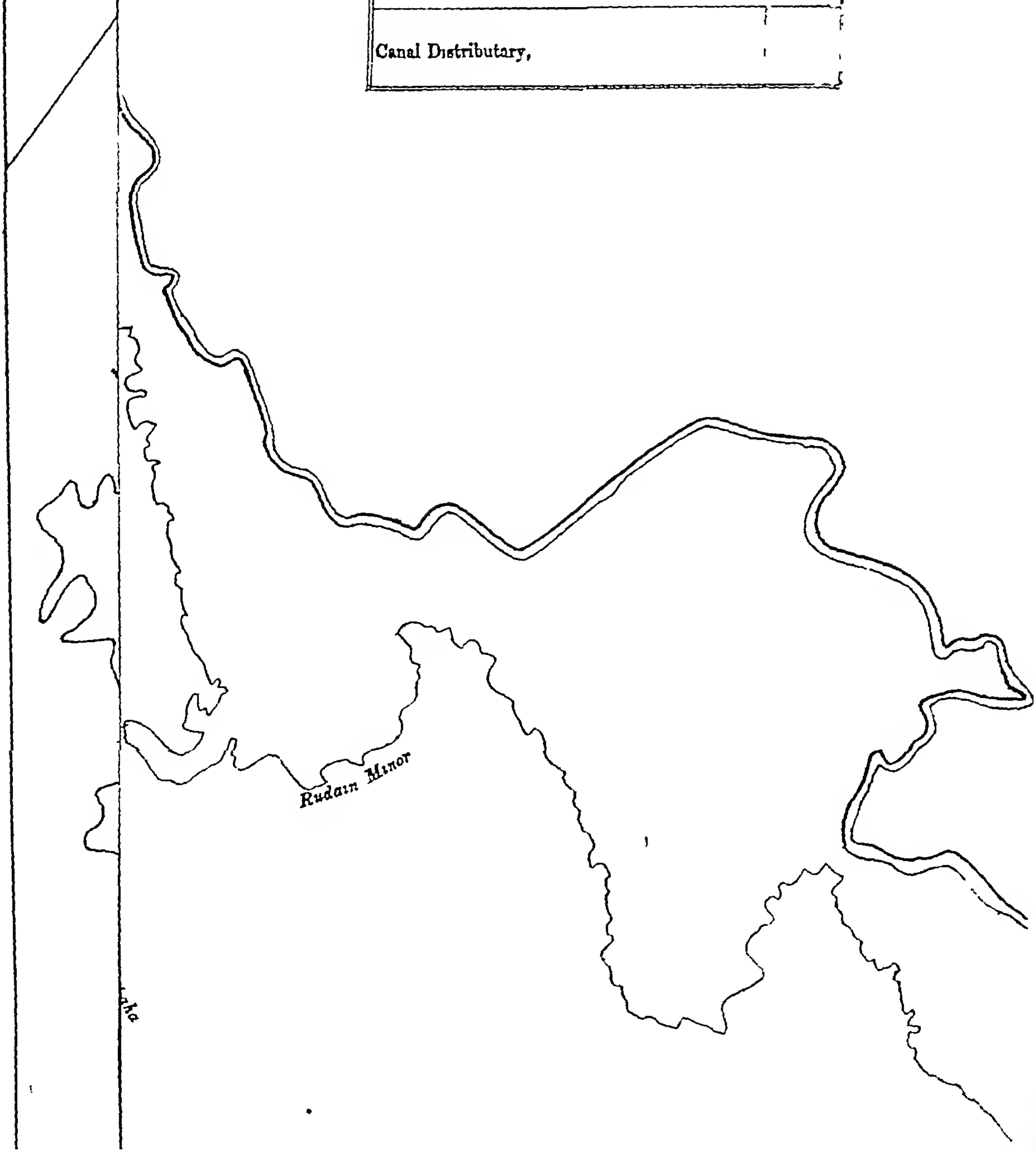
Description of Well.			Name of Village.	Number of wells.	Number of buckets	Area irrigated in acres.	Average area irrigated	
Pucka or Kucha.	Number of buckets worked on each well	Depth from ground to water in well.					By one well.	By one bucket.
		Feet						
Pucka, .	2	24	Begampur, ..	1	2	13·30	13·30	6·65
" ..	2	28	Pasyapur, ..	1	2	14·38	14·38	7·19
"	2	15	Khwájapur, ..	1	2	12·81	12·81	6·40
				3	6	40·49	13·50	6·75
" ..	1	18	Rámpura, ..	1	1	8·25	8·25	8·25
" .	1	12 and 16	Khwájapur,	4	4	32·92	8·23	8·23
"	1	31	Zaimpura,	1	1	8·80	8·80	8·80
" .	1	20 and 22	Chirgawan, .	2	2	16·18	8·09	8·09
" ..	1	21	Faridpur, ..	1	1	6·86	6·86	6·86
				9	9	73·00	8·11	8·11
		Total Pucka wells,	.	12	15	113·50		7·57
Kucha, ..	1	16 and 20	Rámpura, ..	5	5	34·57	6·91	6·91
" ..	1	18 and 27	Ataullahpur, ..	6	6	31·89	5·31	5·31
" .	1	18	Pasyapur, ..	1	1	5·12	5·12	5·12
" ..	1	9 and 10	Khwájapur, .	8	8	67·90	8·49	8·49
"	1	15 and 24	Chirgawan,	21	21	107·13	5·10	5·10
" ..	1	13 and 22	Zaimpura, ..	16	16	95·88	5·97	5·97
" ..	1	18 and 28	Faridpur,	15	15	78·68	5·24	5·24
			Total Kucha wells,	72	72	421·17	5·85	5·85
			Grand Total,		87	534·67		6·15

TABLE IV —*Showing the loss of head in pipes of different diameters*

Diameter of pipe in inches.	Velocity of water in feet per second	Head due to velocity $= h$	Loss of head at the two ends of the pipe $= 1·5\,h$	Value of c for incrusted pipes.	Loss of head due to friction in			Total loss of head in	
					1 foot of pipe	50 feet of pipe	100 feet of pipe	50 feet of pipe.	100 feet of pipe.
Discharge = 900 cubic feet per hour = 0·25 cubic foot per second									
3	5·10	0·40	0·61	0·0133	0·0857	4·29	8·57	4·90	9·18
4	2·87	0·13	0·19	0·0125	0·0191	0·96	1·91	1·15	2·10
5	1·84	0·05	0·08	0·0120	0·0060	0·30	0·60	0·38	0·68
6	1·28	0·025	0·04	0·0117	0·0024	0·12	0·24	0·16	0·28
12	0·32	0·002	0·002	0·0108	0·00007	0·004	0·007	0·006	0·009
Discharge = 1,200 cubic feet per hour = 0·33 cubic foot per second									
3	6·79	0·716	1·07	0·0133	0·1528	7·64	15·28	8·71	16·35
4	3·82	0·227	0·34	0·0125	0·0340	1·70	3·40	2·04	3·74
5	2·44	0·093	0· 4	0·0120	0·0106	0·53	1·06	0·67	1·20
6	1·70	0·044	0·066	0·0117	0·0042	0·21	0·42	0·28	0·49
12	0·42	0·003	0·005	0·0108	0·00012	0·006	0·012	0·011	0·017
Discharge = 1,600 cubic feet per hour = 0·5 cubic foot per second									
3	10·19	1·61	2·44	0·0133	0·3428	17·14	34·28	19·58	36·72
4	5·73	0·51	0·77	0·0125	0·0765	3·83	7·65	4·60	8·42
5	3·67	0·21	0·31	0·0120	0·0240	1·20	2·40	1·51	2·71
6	2·55	0·10	0·15	0·0117	0·0094	0·47	0·94	0·62	1·09
12	0·64	0·006	0·009	0·0108	0·00027	0·014	0·027	0·023	0·036

REFERENCES

Land debarred from Canal Irrigation,	
Ditto ditto ditto *belonging to the Awa Estate,*	
Dhak Jungle,	
Land flooded during the rains,	
Canal Distributary,	



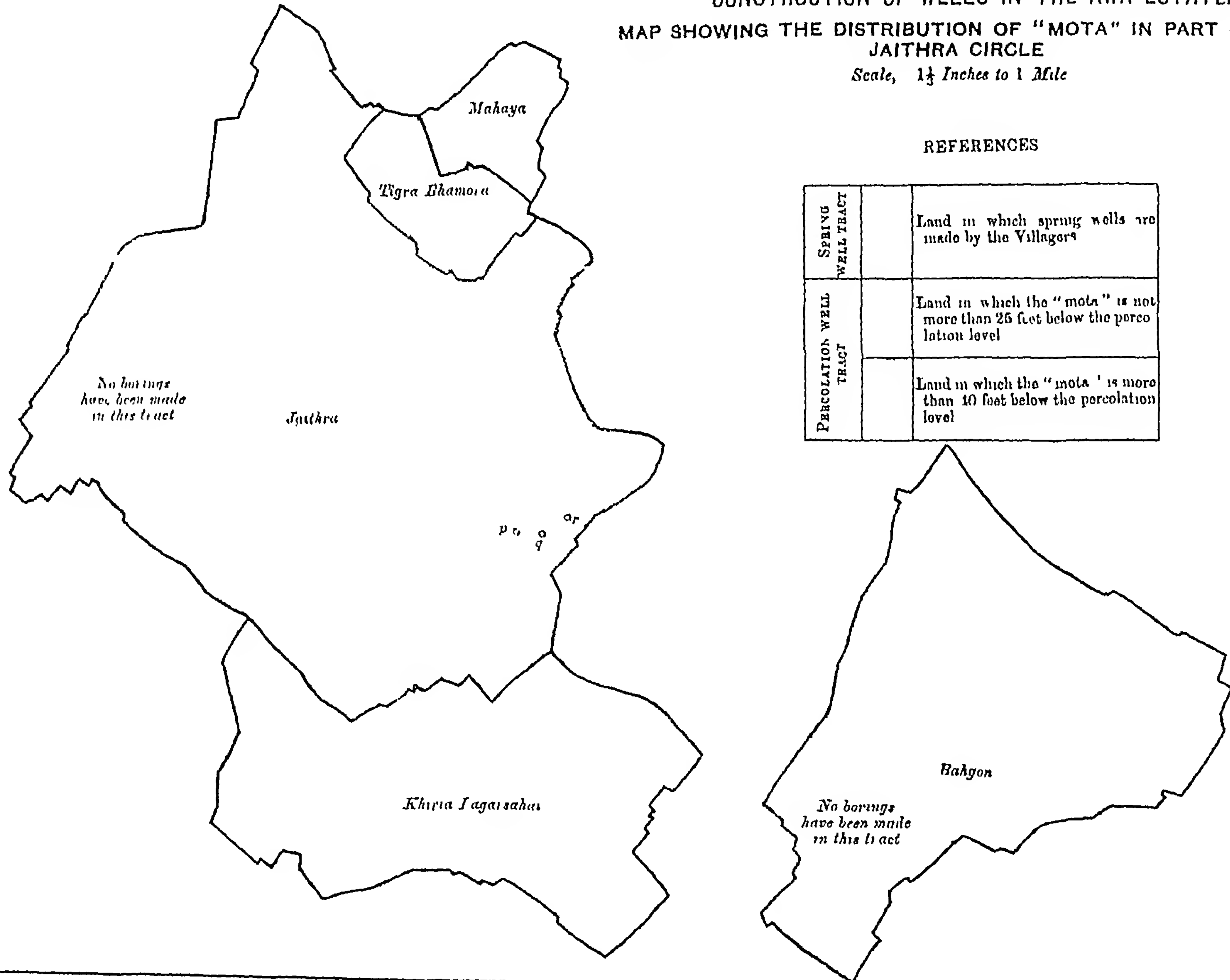
CONSTRUCTION OF WELLS IN THE AWA ESTATE.

MAP SHOWING THE DISTRIBUTION OF "MOTA" IN PART OF THE JAITHRA CIRCLE

Scale, 1⅓ Inches to 1 Mile

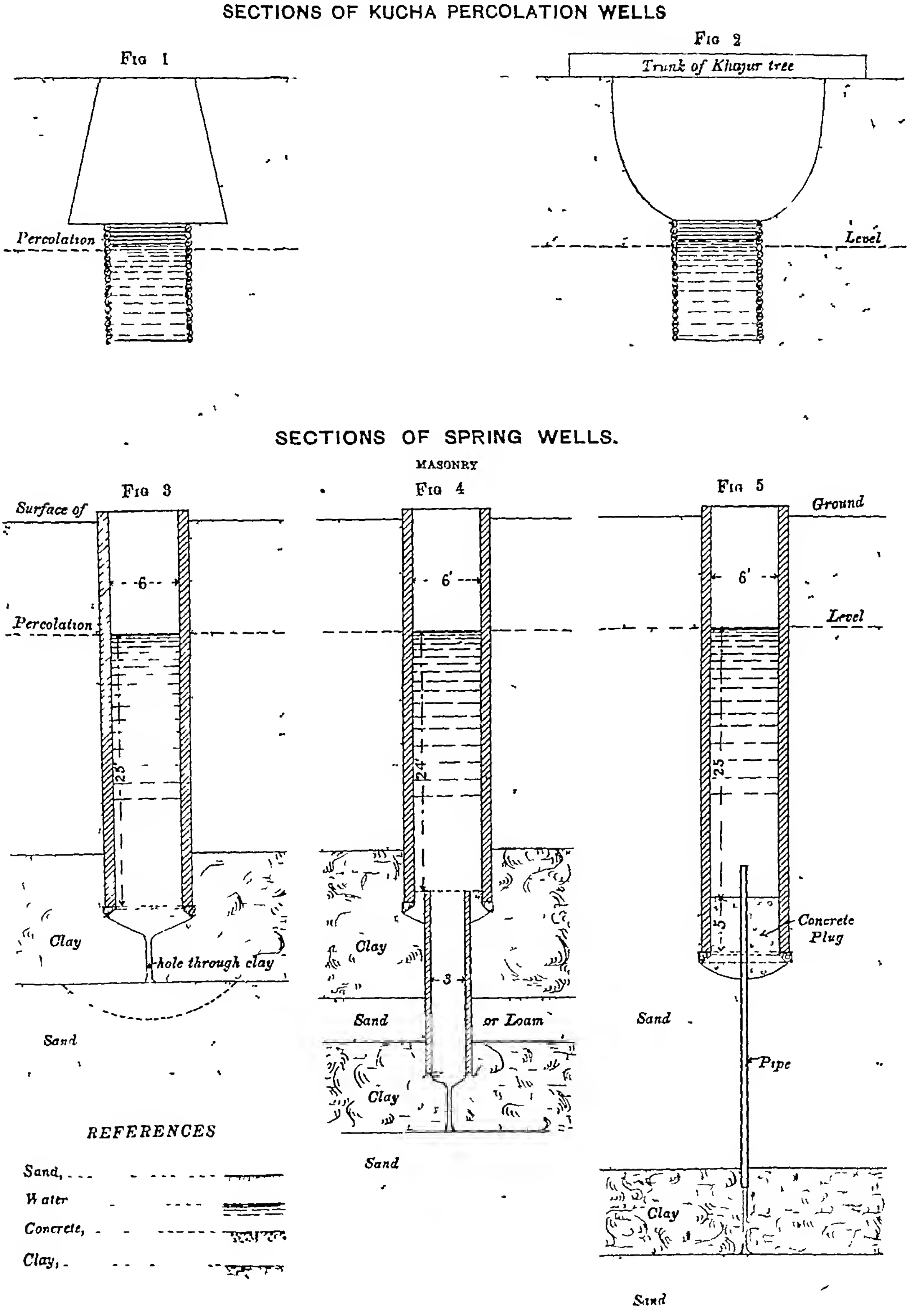
REFERENCES

SPRING WELL TRACT		Land in which spring wells are made by the Villagers
PERCOLATION WELL TRACT		Land in which the "mota" is not more than 25 feet below the percolation level
		Land in which the "mota" is more than 10 feet below the percolation level



CONSTRUCTION OF WELLS IN THE AWA ESTATE.

Scale, 12 feet to 1 Inch



CONSTRUCTION OF WELLS IN THE AWA ESTATE.

SECTION OF PERCOLATION WELL

Scale, 15 feet to 1 Inch

Fig 6

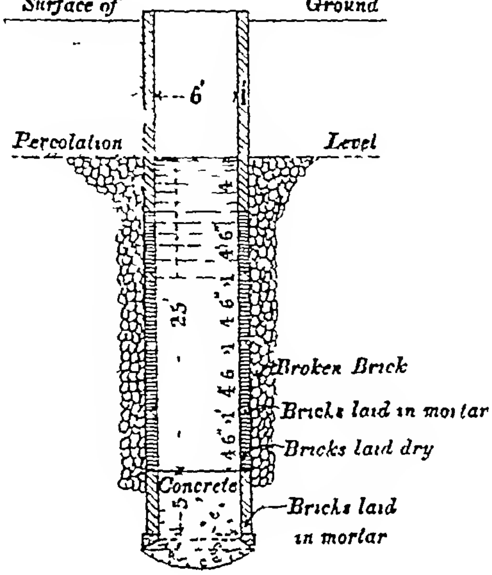


Fig 7

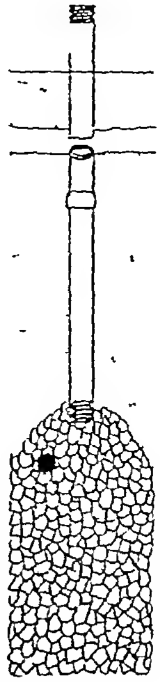
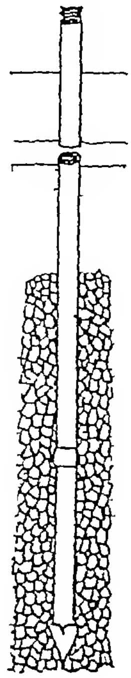


Fig 8



SECTIONS OF SUBSOIL AT

Fig 9
p

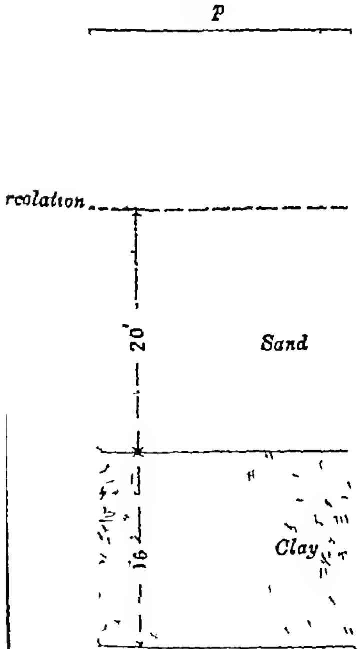


Fig 10
q

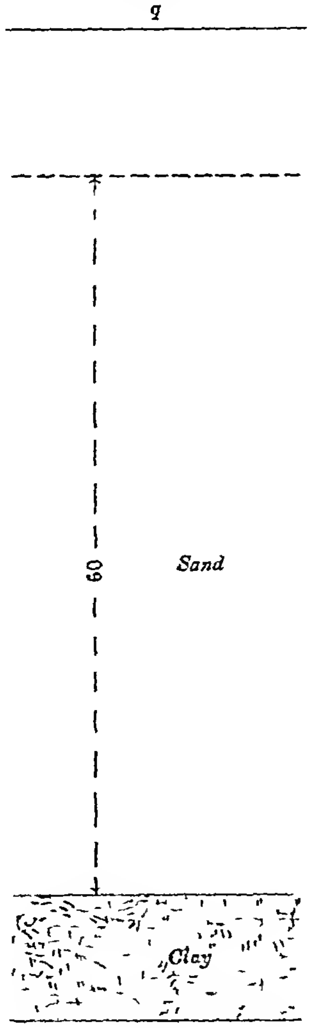
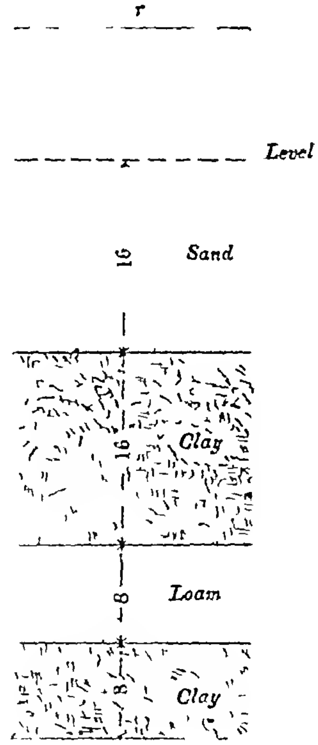
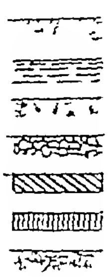


Fig 11
r



REFERENCES

Sand,
Water,
Concrete,
Broken Brick,
Bricks laid in mortar,
Bricks laid dry,
Clay,



NOTE ON THE MORADABAD WELLS.

NOTE

ON THE

CONSTRUCTION OF THE MORADABAD WELLS FROM THEIR INCEPTION IN DECEMBER 1879, TO THE TRANSFER OF MR. MEARES IN AUGUST 1882.

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1 On the receipt of Mr Wright's Report on the Construction of State Wells in Cawnpore, Mr Buck in his covering letter to Government No. $\frac{1800\ A}{cccxiii\ B}$ of June 19th, 1879, urged that the experiments proposed by Mr Smeaton in the Hasanpur pargana (Moradabad) should be carried out under Mr Alexander's supervision, and that further experiments under the same supervision should if possible be made on some adjacent tract where water was near the surface.

2 The suggestion made by Mr Smeaton in his No 858 of April 17th, 1879, was that a score or so of villages on the sandy plateau of Hasanpur should be provided with wells—

(1) —As a security against landlord rapacity and oppression

(2) —As an insurance against famine. He further hoped that they might be the means of introducing a system of water-lift, which he had modified from an appliance in use in Southern and Central India He found from actual experiment that whereas with the ordinary native lift only $1\frac{5}{8}$ of an acre had been irrigated by 16 bullocks and 12 men in 12 hours from a depth of 19 feet, with his improved lift, $2\frac{1}{2}$ acres could be watered from the same depth and the same time by 2 men and 2 buckets The experiment was one which in itself demonstrated the necessity of making investigations which should throw more light on the elementary problems of well irrigation, as though, allowing $2\frac{1}{2}$ inches for the depth of a watering, the results of the experiment with the native *churrus* were reasonable enough, to secure the result reported by Mr Smeaton for his lift would require that each bullock should lift 8 3 foot tons per minute, or 56 horse-power, which is altogether incredible

3 On November 10th, 1879, the Director of Agriculture was authorized by telegram from the Board of Revenue to settle details with Mr Alexander, the Settlement Officer of Moradabad, and in a communication dated two days later, Mr Buck reported to the Board that he had met Mr Alexander, who would undertake the work in combination with Mr Mills, an engineer of the Department of Public Works In this letter, Mr Buck asks for instructions as to whether he is to continue to exercise supervision over the work, and makes a suggestion, the full value of which seems at that time hardly to have been appreciated, *i e*, that some attempt should be made to get boring tools which would show whether or no wells could be constructed

4 On December 9th, 1879, Mr Mills joined at Moradabad, and a few days later Mr Alexander reported that the work of collecting materials had commenced Rods, augers, pipes and a crab-winch were provided from Roorkee for boring operations

5 The nature of the objects to be aimed at was described in some detail in Mr Buck's letter of December 12th, 1879

The object of Government (he says) is to ascertain how in each locality wells can be most conveniently constructed, and what arrangements between cultivators and zemindars are most suitable What is desired is that these experiments should enable Government to frame a scheme for general adoption The special points on which information is wanted are—

No 3141

(1)—What rental return actually is obtained for the advantage of well irrigation

(2)—What area is irrigable from each well,

(3)—What increase of revenue can be expected at next settlement, and on what terms should the assessment be made

6, Details of construction were to be settled in consultation with the Engineer, and it was important to extend the experiments to tracts where water was nearer the surface than it was at Hasanpur In a subsequent letter (January 3rd, 1880) Mr Buck insists that, as the experiments are not local but provincial, more than one kind of well shall be constructed The Engineer should have full latitude to construct any kind of well that had a *primâ facie* prospect of success He again hopes that a tract may be found where water is much nearer the surface than at Hasanpur, and where cultivators, while willing to use them, are unable to construct permanent wells.

7, Mr Alexander on his part made a number of suggestions, the most important of which are found in his letter to Mr Buck of January 13th, 1880 He there proposes to build 50 (presumably) four bucket wells at an estimated cost of Rs 650 each, allowing nothing for cost of supervision These wells were to be distributed into the following classes.—

(*a*)—Twenty wells—the zemindars were to buy them outright by payment of the cost of construction in a lump sum or by instalments, interest at 6 per cent being charged on outstanding balances.

(*b*).—Fourteen wells—the zemindars were to manage these and pay interest only on the cost of construction, with option of purchase at any time. In this case the interest was to be 8 per cent payable for a minimum period of 20 years

(*c*)—Eight wells Government was to have the management, and the zemindars to guarantee Government a certain income as long as the wells were kept in working order The income in this case was to be 5 per cent on the cost of construction, and as Government being the manager, would take all the increased rents secured by the wells, the zemindars would only be called on to pay the guarantee in the event of the wells proving a financial failure, a result of which there appears to have been no presentiment

(*d*)—Eight wells were to be built as a pure speculation and without any guarantee. The two latter suggestions appear to be explained by a passage in a previous communication, in which Mr Alexander proposed that a certain number of wells was to be built for cultivators, and crop rates, analogous to those charged for canal water, collected by the Tahsildar There is no suggestion as to how Government was to acquire the land He urges that unless a large number is constructed the experiment will be inconclusive, and adds: the main object will be gained if a certain tract is protected from famine and actual loss avoided, and that an all round return of 5 per cent would be very satisfactory

8 Throughout the earlier stages of this experiment three entirely different and not easily reconcilable views of what was to be its aim seem to have held the ascendancy in turns.

(1)—The wells were to protect this particular tract from famine

(2)—They were to be made as a commercial speculation

(3)—They were to enable Government to ascertain by actual experiment on what terms and under what conditions it could build wells all over the Provinces

9 Mr Buck applied for a grant of Rs 25,000 for the Hasanpur wells, and Rs 5,000 for the wells which were to be constructed in a tract of high water level, and the Board

sanctioned Rs. 15,000 to be spent during the current year, instructing Mr. Buck to furnish an estimate of what would be required in the ensuing year for inclusion in their budget They further directed that the rate of interest chargeable to zemindars should be 6½ per cent This ruling was subsequently modified by Government, which authorized Mr Alexander to charge at his discretion any rate between 4½ and 6½ per cent, provided that arrangements were made for the recovery of the principal within 20 years In a letter dealing with this point Mr Buck remarks that 5 per cent will be too low a rate to charge for interest, as Government will undertake repairs

10 On January 30th, 1880, Mr Alexander was authorized by Mr Buck to construct 25 wells in any case, and 25 more if they did not interfere with his project of building experimental wells on the tracts of high water level, and the experiment was thus commenced—in the joint charge of Messrs Alexander and Mills, and under the general supervision of Mr Buck

11 The money advanced was placed, by the order of Government, at the credit of Mr Alexander at the Moradabad treasury, and not at the credit of the supervising department The Accountant General was directed to pass disbursements on the Settlement Officer's order

12 Mr Mills was in charge of the engineering part of the work for about five months He fell ill, and went on leave some time in May 1880 The exact date of his giving over charge has never been ascertained Of what was done during that period there is no very clear record, but I can say from what I learnt when at Amroha in October last, that there had been considerable activity in the direction of engineering experiment The first difficulty to be encountered was one which has not even yet been overcome, and which while it has been fatal to the financial success of the undertaking, gives it its whole value as a pure experiment It was found that, while the water level was very much higher than appears to have been anticipated, in fact so near the surface of the ground, that any experiments with wells at higher water levels were quite superfluous, in the great majority of cases no clay could be reached except at enormous distances, if at all, and it became abundantly evident that to construct a remunerative well on the ordinary principles was a sheer impossibility It then occurred to Mr Mills that an effective well might be constructed by sinking a masonry cylinder in the sand to such a depth as to allow for the free play of the bucket in periods of maximum exhaustion, and that the supply of water might be obtained through a tube sunk from the bottom of the well till it reached and pierced the clay stratum To test these views a tube was sunk in an old and exhausted well belonging to Ghulam Chisti Khán, at Hasanpur, to a depth of 77 feet below the ground and 44 feet below the percolation level At that depth it tapped the clay, and as an immediate result the well, which had hitherto been nearly empty, received a copious supply of water Success seemed assured, and the only problem left to solve was the proper diameter of the tube, and the cheapest and most durable material It was not till nearly two years later, in October 1881, that the experiment was discovered to be inconclusive

13 As iron was too dear to be used with any prospect that a well built with it would pay interest on cost of construction, experiments were made with other materials Segmental bricks, or clay tubes sunk inside an iron tube, which was afterwards to be withdrawn, were tried without success Proposals were made to fill the iron pipe with coarse sand and then withdraw it, or to sink a very thin and inexpensive iron pipe and leave it in the well, with a clay pipe inside to strengthen it Eventually it was determined to adopt a suggestion made by Mir Muhammad Muhsin Khán, the very intelligent zemindar of Amroha, to sink pipes of gular wood, which he bored at his own house by a very ingenious machine invented for the purpose by himself

14 There is no clear record of the amount of work done during the five months when Mr Mills was in charge It appears that a large supply of bricks had been burned, a few borings been made, and, as mentioned above, the tube sunk in Ghulam Chisti's old well, and a considerable number of experiments made with different kinds of tubing

15 On Mr Mill's departure Mr Alexander was left in sole charge without any professional assistance, except that of a native Sub-Overseer on Rs 25 per mensem, of whom

it was subsequently reported that he was old and inefficient, and had never done anything but desk work.

16 On May 25th, 1880, Mr Alexander reported further difficulties on his side of the undertaking The zemindars in many cases had stubbornly refused to enter into any engagements for the repayment of the money to be spent, and were willing if not anxious to see their tenants ruined He made two new proposals Either the cost of the wells should be made repayable in 12 yearly instalments, and made an addition to the revenue at which they had recently been assessed, or the zemindars should be compelled to collect crop rates from the tenants benefited by the wells, and receive a small percentage for their trouble. Mr Wright, who then officiated as Director, forwarded the proposals with the remark that both at Cawnpore and in Moradabad zemindars showed an unconquerable objection to the construction of wells by the State, and a recommendation that compulsory measures should be resorted to The Board, however, negatived both Mr Alexander's proposals, and directed that where the zemindars agreed, bonds should be taken, and where not, the cases should be reported They had already demanded Mr Alexander's final Report and the Director's review of it.

17. The first regular Progress Report was sent in by Mr Alexander on August 24th, 1880, and the state of the undertaking at that time was as follows.—Fifty wells had been projected—29 in Hasanpur—18 in Amroha, and 3 in Sambhal—of these one, the old well in Hasanpur Khas, of which mention has been made, had been completed, in two other old wells a tube had been sunk to nearly a sufficient depth; a fourth old well had been sunk to 18 feet beyond its original depth. Of the remainder, 15 or 16 feet of masonry had been built and sunk in three, the same height of masonry had been built but not sunk in 13, in 23 the bricks and curb were ready, the pits dug for most of them, and in some building commenced, in others delayed for want of lime. For three, the curb only had been made, for one other, the curb was being made of three, those in charge of the zemindar of Keshopur Bhindi, no details are given. The arrangements with zemindars were not fully completed, and are more fully reported in Mr Alexander's next detailed communication.

18 In the same month Government gave the important ruling that the Engineer's pay was not to be charged to the Government advance for wells A small sum, the exact amount of which was left to the Settlement Officer's discretion, was to be added on this account to the money repayable by the zemindars, as otherwise the real cost of construction would not be known, and one of the principal aims of the experiment would be defeated.

19 Mr Alexander, with his assistant Mr Darrah, had been in the constant habit all through the hot weather and rains, of driving to the well tract, the nearest point of which was 25 miles from the station, whenever a Sunday or holiday released them from the pressure of their regular work. But the wells themselves were scattered over a very large area, the best supervision a civilian could give would be little better than futile, and in answer to Mr Alexander's urgent appeals Captain Bellasis was appointed, and took over charge of the engineering part of the work on December 25th, 1880

20 On the first day of 1881, Mr Carmichael visited Rajabpur, Hasanpur and Amroha, and inspected the wells which were in course of construction in that neighbourhood. He found that the question of material for tubing was still undecided. Iron, earthenware, and gular wood were all being tried at the same time in different wells Natives were watching the experiment with interest, and Mr Carmichael had no doubt that a large number of applications for wells would be the result if it succeeded. Mr Carmichael indicated as the weak points of the experiment that Mr Alexander had been under the mistaken impression that he was justified in resorting to compulsion, and that the wells were scattered over far too wide an area.

21. In connexion with this visit, Mr Alexander drew up a second Progress Report explaining his action, and again commenting on the hostility of the zemindars, which he attributed mainly to what was no doubt one of the chief causes, the commutation of their tenants' rents from grain to cash payments, which was then in progress under his orders

22 The arrangements for repayment of the money which was to be spent were as follows —

(a) —For seventeen wells, Mir Muhammad Muhsin Khán engaged to pay the cost estimated after completion, provided that it did not amount to more than Rs 400 per well, with 5 per cent on outstanding balances within 12 years Interest to run from the date of the bond

(b) —Bonds had been taken from Ghulam Chisti Khán for nine wells The period in this case was 10 years for three wells and 12 for the remainder, and there was a slight difference in the method of calculating the principal sum

(c) —In eight cases bonds were taken from the neighbouring cultivators who used the wells They were to repay the consolidated principal and interest in 20 years by annual instalments

(d) —In three cases annual water rates were accepted by the neighbouring cultivators

(e) —The actual money advanced to the zemindar of Keshopur Bhindi was to be recovered in 15 years. Interest at 5 per cent. and the principal being consolidated Government incurred no responsibility for the construction

(f) —Four were Government property or in Court of Wards, and for one it had been found impossible to come to terms with any of the inhabitants, and Mr Alexander eventually paid its cost out of his own pocket.

23 At this time the distinction is at first clearly drawn between the (about) 25 which were being constructed by contractors under direct supervision, and the 20 which were being made under the superintendence of the zemindars The latter were the 17 undertaken by Mir Muhammad Muhsin Khán, and the three in Sambhal

24 The Progress Report up to the time when Captain Bellasis took over charge shows the following results of the first year's operations on the wells under direct Government supervision —

(a) —Completed with tube—one This was the old Hasanpur well

(b) —Cylinder completed and tube partly sunk—one

(c) —Cylinder completely built and sunk but no tube—four

(d) —Cylinder partly built and sunk—fourteen

(e) —Bricks collected—four

(f) —To be abandoned—one.

25 During the cold weather of 1881 Mr Alexander, who may be regarded as the originator of the experiment, and who had been in charge since its initiation, went on leave Captain Bellasis also left the work after he had been in charge for nearly four months, and the prosecution of the experiment was left to Mr Meares, the Executive Engineer of Moradabad, who took over charge from Captain Bellasis on April 17th, 1881

26 His first action was to send in a Progress Report which showed the following results for the wells under direct supervision

(a) —Completely finished—one at Hasanpur

(b) —Cylinder finished and tube sunk to what might be a sufficient depth—three

(c) —Cylinder finished and pipe partly sunk—two

(d) —Cylinder finished but no pipe—nine

(e) —Cylinder partly built and sunk—seven

(f)—Cylinder partly built but not sunk—two

(g) —No work done—four

This list includes two wells which are not found in Mr Alexander's Progress Report They never advanced beyond the stage of collecting a few bricks

27 Mr Meares retained sole charge of these wells till September 27th, 1881. When on his representation that his ordinary district duties interfered with their proper supervision, Mr Sub-Conductor Edwards was sent to take over the work under Mr Meares' orders

28 During the last fortnight in October 1881 I inspected as many wells as were sufficiently advanced to admit of being tested in the company of Mr Wilson, the Departmental Engineer

The work up to that date had accomplished the following result —

(*a*) —Reported as completely finished—twelve
(*b*) —Cylinder finished and clay pipe sunk and broken off—one
(*c*) —Masonry finished and only tube wanting—four
(*d*) —Masonry partly built up and sunk—six.
(*e*) —Pit only dug—two
(*f*) —Not commenced—two

29 The wells reported as finished were tested by Mr Wilson and myself by the simultaneous use for about $1\frac{1}{2}$ to 2 hours in each case of a bucket holding about 25 gallons, and a Cawnpore farm pump The amount of water drawn was about 500 cubic feet in the hour, and in only one case did any well show signs of exhaustion As far as the water supply went the result was perfectly satisfactory, and showed the possibility of irrigating the area estimated by Mr Alexander, *i e.*, between 20 and 30 acres for a two bucket, and between 40 and 50 for a four bucket well

30 Three only of the wells had reached the clay stratum One of these had not been sunk to a sufficient depth to provide a sufficient supply of water

The other two not only supplied ample water, but were perfectly free from any invasion of sand They were absolute successes

31 But in the remaining eight, which may be taken as typical of the wells over the whole tract, a defect was disclosed which does not appear to have been anticipated, and which, unless remedied, would prove fatal to their utility The cylinders rested on sand, which, when the water was drawn, rushed in, and filled them up to a depth which ranged from 2 feet 6 inches in a well which was only tested for nineteen minutes, to as much as from 4 feet 8 inches to 8 feet 3 inches in those which had been tested for longer periods It was not clearly ascertained how much of this sand came up through the pipe, but it was plain that the greater part, if not all of it, came from under the curb, and that the work of only a few days would leave the cylinders suspended over a vacuum in which they must very soon be engulfed

32 The first step necessary was therefore to plug up the bottom of the wells in such a manner as to exclude the sand When that had been done, it remained to be seen whether the pipe itself would not bring up sand enough to endanger eventually the safety of the wells Mr Meares, who accompanied us for the greater part of the time in which we were engaged on the testings, thought that a plug of kunkur in layers of graduated sizes might act as an effectual sieve, admitting water but excluding the sand This experiment was sanctioned, and on December 18th, 1881, at the suggestion of Captain Clibborn, I directed that the further experiment should be tried in one well at least of plugging it with an impermeable layer of concrete, thereby leaving the whole of the feeding to be done by the tube The tubing then being used was the gular wood pipe made by Muhammad Muhsin Khán, and of 5-inch diameter It appears to answer well, but it remains to be seen how it will stand the test of time

33 In December 1881, Mr Meares reported that he was not satisfied with the work done by Mr Sub-Conductor Edwards, and suggested that he should be sent to his ordinary duties, Mr Meares being relieved of his district duties and put in exclusive charge of the wells The arrangement was sanctioned, and came into effect in the beginning of February 1882

34 Early in February Mr Meares reported that he was in want of funds It was necessary to make some enquiries relative to his statement of accounts, but in the meantime

Rs 2,000 were sanctioned by the Board of Revenue in March to prevent the work coming to a standstill

35 On April 14th I received an order from Government directing me to close the wells by the end of that month current I ventured to give reasons why this order should be reconsidered, and received at once assurances that this should be done, assurances which were carried into effect by Government Order 715 of May 8th, 1882 In Government Order 967 of June 7th, 1882, it was ruled that the extra expense of Rs 600, which had been applied for by Mr Meares might be sanctioned on the understanding that the wells should be completed for that amount But in the meantime the Board of Revenue had forwarded the earlier order direct to the Collector of Moradabad, with instructions that all work on the wells should be closed by April 30th The first news I received of this was by a letter from Mr Meares informing me that he had already taken charge of district work I at once addressed the Board, and on the urgent representations of both Mr Tracy and Mr Meares, it was agreed that he should retain charge of the wells as a part of his ordinary district work, an arrangement which had already been sanctioned by his Department when his connexion with them began a year before Things remained on this footing till the middle of August, when a private communication from Mr Meares to the effect that he had been transferred from Moradabad was again the first intimation I received that the continuity of the experiment was threatened He left the work under orders from the Chief Engineer some time in the last week of August, and this is a convenient date to bring the history of the experiment up to

36 It remains for me to revert to the Engineering part of the operations Early in April, Captain Clibborn visited the wells at my request, and reported that he had tested two wells That at Rajohan, which had reached clay, and which was the only one except the old Hasanpur well, which Mr Wilson and I had found to be perfectly successful when we tested the wells in October, was subjected to a severe strain for nine hours and showed no signs of exhaustion or subsidence Our conclusions were fully confirmed by this second trial, and it may be accepted as a complete success

The second well, at Chak Dhanori, had been fitted with a ballast plug, and was, as Mr Meares told Captain Clibborn, fairly typical of the class of wells which had been sunk This too was severely tested for nine hours, and the result proved conclusively that the ballast plug was useless as a sieve to pass water and stop sand The well began to crack an hour after the drawing was commenced, and in five hours had sunk 1 foot 5 inches into the ground Before the end of the trial it was choke full of sand, and no water came in except a little through the tube, and that, it is interesting to remark, was still perfectly clear and free from sand. The whole of the sand then must have come from under the curb through the ballast plug The cylinder had subsided, leaving the ballast plug in its old position as far higher within the cylinder as the cylinder had sunk into the ground

Captain Clibborn further reports, that Mr Meares found it beyond his power to bring the accounts from the beginning of the operations into an intelligible form

37 On this report Mr Meares was again directed to try a concrete bottom, and the Examiner of Public Works Accounts was asked to put a trained accountant at his disposal for as long as the clearing of the accounts might require him The accountant joined Mr Meares on May 1st, and submitted a detailed account on August 1st I have omitted to say that in April, when the question of advancing more funds came up, I had directed Mr Meares to abandon two wells in which only a little work had been done up to that time The number remaining under his direct superintendence was 23

38 On May 4th, Captain Clibborn made a second inspection of the wells, and with Mr Meares sunk a concrete plug 4 feet thick in the bottom of the Chak Dhanori well, effectually closing all entrance either of water or sand except through the pipe He further tested the Majhola well, in which Mr Wilson had found that though it reached the clay, the supply of water was insufficient Since then the bottom had been strengthened and the pipe driven further in with the effect of entirely remedying its previous shortcoming It gave 3,600 cubic feet in 6½ hours

39 It took three weeks for the concrete in the Chak Dhansri well to harden, and on June 30th and 4th, four testings were made under Mr Meares' personal supervision The results were as follows —

	Time.	Water drawn.	Deduct for reduced content of well	Delivered through tube.
1st testing,	1–15	441 c ft	308 c. ft.	133 c ft
2nd "	2–0	962 5 "	448 "	514 5 "
3rd " ..	3–0	906 "	450 "	456 "
4th " ..	1–5	619 "	448 "	171 "

The testing, especially in the fourth experiment, when 531 5 cubic feet were drawn in 50 minutes, was much more severe than previous experiments would have justified, but the result was not discouraging No sand came into the well, and only 2 feet 6 inches into the 80 feet of tube Neither tube nor cylinder were in the least disturbed The only result which was not wholly satisfactory was that the water supply had been considerably diminished The well, which was 6 feet in diameter and was intended for two buckets, only gave a discharge of about 1,500 cubic feet in the day, which is not more than what would be taken out by a single bucket by a not very efficient cultivator

40 On June 29th, Mr Meares again went to the wells, and set testings going, which were continued for three days after he had returned to Moradabad On the first day no sand came into the tube—on the second only trifling amounts These experiments were conducted in his presence On the fifth day (July 3rd), when he was not there, a most surprising result was reported—350 buckets, or about 1,225 cubic feet, were drawn in four hours, no sand came up while the water was being drawn, but when operations were suspended there was a sudden rush which filled up the tube and one foot of the cylinder This extraordinary phenomenon is reported in a way which leaves much to be desired in the way of clearness, and I very much doubt whether it was correctly understood It is possible that the fine sand suspended in the water of well left a sediment of one foot when the drawing stopped, which deceived the natives in charge of the experiment, and that the rush was merely a conjecture on their part

41 The experiments were conducted till the 18th of July, chiefly under native supervision The well was worked generally for four hours at a stretch, and fifty buckets (say 175 cubic feet) taken in the hour Only a very few feet of sand came up the tube, and none into the cylinder The result showed that, even if the report of July 3rd is to be accepted, and it is dangerous to work at the rate of 88 buckets to the hour, the well is perfectly safe with a draft of only 50 buckets to the hour, and that the limit to which it can be worked with safety is something more than 50, but less than 88, buckets to the hour

This was the last experiment, and I have nothing further to report

42 The position in which Government stands at this stage of the experiment is as follows —

It has 23 wells in pargana Hasanpur, in all of which the cylinder has been fully sunk, and tube sunk to as great a distance as seems necessary Of these

One (1) in Hasanpur has long been an established success

One (2) in Rajohan, } have been lately proved successful
One (3) in Majhola, }

Two { (4) Padh,
(5) Sahadra,

are reported to rest on clay and should therefore be successes, but they have not been tested

Six {
(6) Dehri Jat, No. 1,
(7) „ „ 2,
(8) Bahadurpur
(9) Bawan Kheri, No 1,
(10) „ „ „ 2,
(11) Rajohan, „ 2,
}
were tested in October 1881, and found to be unsafe Ballast or kunkur plugs have since been sunk in all, but testing has been deferred pending the results in Chak Dhanori.

One (12) Chak Dhanori—the condition of this well has been reported in detail

Nine {
(13) Karanpur, No 2,
(14) Ekonda, „ 1,
(15) „ „ 2,
(16) Baldana,
(17) Hashimpur,
(18) Hayatpur,
(19) Muhamdi,
(20) Manota,
(21) Rampur,
}
have not been tested, and it is supposed that their cylinders rest in pure sand. The pipes are reported to end in coarse sand and kunkur

One (22) Karanpur No 1 has not been touched since it proved a complete failure in October 1881

One Sadhpur I am told by Captain Clibborn that this well was tested in April by Mr Meares, and that the cylinder has parted 22 inches below the ground surface, making the well useless I have no official report on this, though I believe Mr Meares mentioned the occurrence in a D O letter

43. Besides there are 17 in the charge of Muhammad Muhsin Khán in Amroha He was showing considerable activity in the construction of these up to the time of last October's testing He then seems to have suspended operations till he saw the results of the efforts that were to be made to exclude the sand.

No report has been made relative to the three wells in Sambhal which were to have been built by the zemindar of Keshopur Bhind .

44 On these wells bonds have been taken as described in para. 21 for the following —

(a) —Hasanpur, Karanpur Nos 1 and 2, Baldana, Hayatpur, Muhamdi, Ekonda Nos 1 and 2, and Rampur, from Ghulam Chisti Khán

(b).—Bawan Kheri Nos 1 and 2, Chak Dhanori, Rajohan Nos 1 and 2, Sadhpur and Padli, from the cultivators.

(c).—In Bahadarpur, Majhola, and Hashimpur, crop rates have been assessed on the cultivators

(d) —The two wells in Dehri Jat are in the Court of Wards, and the well on Sahadra in Government property Mr Alexander has paid for the Manota well Rs 369-5-0—the total cost on that having been Rs 408-11-6

(e) —A bond has been taken from the cultivators for a well in Tigaria, which has been since abandoned.

(f) —Bonds have been taken from Muhammad Muhsin Khán for the cost of seventeen wells, and the sum of Rs 4,528-12-7 has already been paid on account

(g) —Rs 1,000 has been advanced to the zemindar of Keshopur Bhindi

45 The steps remaining to be taken appear to be the following —

(1) Careful testings should be continued at the Chak Dhanon well, and it should be ascertained how many buckets per hour can be drawn with safety. The Engineer in charge could be furnished with instructions as to how this testing might be accomplished They are too long and too technical for this report.

(2) Most of the tubes end in nodular kunkur The reason for this was probably the difficulty of driving a wooden tube through such a stratum But an iron pipe could easily be put down as a continuation of the present wooden ones It has usually been found that a layer of nodular kunkur immediately covers a layer of clay Trial borings might be made in the tubes of the Moradabad wells by Mr Wilson's sand pump, and if they proved that there was a clay stratum within a few feet of the end of the present pipes, the wells might probably be made perfectly efficient at a very small cost.

(3) There are reasons for believing that both the water supply might be increased and the flow of sand diminished if the hollow formed under the end of the tube were filled with bits of kunkur and hard stone. This could easily be tried. The cylinder should be emptied as far as possible, and a man sent down to drop the kunkur into the tube He should occasionally let a line down to see that the tube was not being filled up.

(4) Wells 4 and 5 should be carefully tested. It is possible that nothing further need be done to them

(5) The ballast or kunkur plugs should be taken out from beneath the cylinders in wells 6 to 11, and impermeable concrete plugs substituted

(6) Wells 13 to 21 should be tested, care being taken not to subject them to such a strain as to endanger the stability of the cylinder If, as will probably be the case, it is found that sand comes up from under the cylinder they too should be supplied with impermeable plugs

It should be left to the Engineer in charge to say whether it would be worth while to repair the broken wells at Karanpur and Saahpur, or whether they should be abandoned

46 There appears to be no reason why the agreements taken for the three first wells on the list should not be enforced In every other case they should be held liable to revision until the well has been finally pronounced on The terms then to be exacted would depend on the safe water supply Perhaps a capital sum calculated on the rate of Re 1 for every cubic foot drawn during the hour would be a fair charge That is to say, a well that would give a hundred buckets, each holding four cubic feet in the hour would be worth Rs 400, of course the limit originally agreed on would never be exceeded

47 I have made no proposals as to the course to be adopted with Muhammad Mohsin Khán. That can only be determined when the experiments now in progress on the wells under direct supervision have been pushed to completion. He shared the sanguine views entertained at the commencement of the experiment, and whatever has been achieved is largely due to his eneregetic co-operation He deserves I think to be treated with much consideration

48 The statement of expenditure is taken from the accounts furnished by the accountant who was deputed to draw them up in May last Since the commencement of the work there have been five officers in immediate charge, and four different Directors of Agriculture This, and the fact that, owing probably to the funds having in the first instance been placed by Government at the disposal of the officer in charge, and not included in the budget of this department, no monthly audit bills have ever been furnished, has added very greatly to the difficulty of clearing up the financial aspect of the experiment This must be my explanation of the discrepancies which occur between the cost of the finished wells which I reported in December last, and the cost of the same wells now given by the accountant.

49. The whole sum advanced by Government has been Rs. 27,600, and against this the savings up to the time when the accounts were made up appear to have been as follows —

	Rs.	A	P.
Cash in Engineer's hands, .	53	15	4
Credit at Treasuries, .. .	2,888	15	7
Lapsed, ...	2,408	14	0
Total Rs, ..	5,346	12	11

This would make the total expense to Government up to the same date Rs. 22,353-3-1, of which Rs 5,528-12-7 have been advanced to Muhammad Muhsin Khán and the Zemindar of Keshopur Bhindi, leaving Rs 16,824-6-6 as the sum spent on constructing the wells under direct supervision, on tools and plant, and on experiments. The amounts under each of these heads, as far as I can understand the accounts, have been as follows —

	Rs	A.	P
Construction, ...	13,314	8	7
Tools and plant, ..	2,449	11	8
Experiments, .	1,035	15	5
Total Rs, ..	16,800	3	8

Which leaves an unexplained balance of Rs 24-2-10

50 As has before been pointed out, it is impossible to say how much of this sum may be recoverable when the work has been completed

51. Mr Meares has furnished me with an account of the sums expended under the superintendence of each officer during the time he was in charge I have not been able to make it tally exactly with the other accounts, but it seems to be approximately accurate —

	Work.			Tools.		
Mr Mills, (5 months,)	5,690	13	10	1,271	11	4
Mr Alexander, (8 months,)	5,412	4	8	456	8	6
Capt. Bellasis, (3½ months,) .	2,426	5	0	187	11	3
Mr Meares, (10 months,) ...	3,509	13	10	470	1	7
Mr Edwards, (4 months,) .	1,146	14	11	124	0	0

52 It cannot be said that the present experiments throw any light on the cost of masonry for wells, and this is so well known already that the defect is hardly a matter for serious regret The cost of sinking tubes is less generally known, and some details which were given me by Mr Meares in October last may be of interest. He found the cost per lineal foot to be as follows —

	Rs	A	P
Iron tubing, . . .	2	0	7
Sinking, ...	1	14	0
Total Rs.,	3	14	7
Wood tubing, . ..	0	11	0
Sinking, ...	1	0	0
Total Rs, ...	1	11	0
Earthenware tubing, ...	1	10	4
Sinking, ...	3	0	8
Total Rs, ...	4	11	0

NAINI TAL, 3rd *October*, 1882. (Signed) W. C BENETT, *Director*

Number	Site of Well	Diameter	Depth to water surface.	Height of cylinder	Length of tube.	Cylinder rests on	Pipe rests on.	Total Cost. Rs.	A.	P.	Value originally estimated Rs.	A.	P.	Secured by	Remarks.
1	Karanpur I, ..	6' 0"	10' 0"	38' 7"	82' 0"	Sand	Clay	548	14	1	400	0	0	Bond, Ghulam Chisti Khán	An old well has been built up and sunk 18 feet and pipe put in
2	Karanpur II, ..	8' 0"	13' 0"	41' 0"	73' 0"	Sand	Sand and kunkur	684	8	8	600	0	0	" " "	Not tested.
3	Ekonda I, ..	8' 4"	11' 6"	30' 7"	8' 0"	Sand	Kunkur	923	8	5	700	0	0	" " "	Not tested—kunkur stratum probably 9" thick
4	Ekonda II, ..	6' 0"	10' 0"	30' 9"	20' 0"	Sand	Sand	413	10	10	400	0	0	" " "	Pipe in progress, May 1882—no test
5	Sahadra, .	6' 0"	12' 6"	30' 0"	Nil	Clay	Nil	409	0	11	450	0	0	Government property	Clay bed 3 feet thick—no test.
6	Padli, .	6' 0"	10' 0"	30' 0"	8' 0"	Sand	Clay	407	11	0	450	0	0	Bond, from cultivators.	Clay 1 foot thick—no test
7	Hashimpur, .	8' 8"	9' 0"	30' 0"	30' 0"	Sand	Sand and kunkur	611	12	1	450	0	0	Crop rates.	
8	Sadhpur, ..	6' 1"	11' 8"	32' 5"	8' 7"	Ballast	Sand and kunkur	437	12	10	400	0	0	Bond, from cultivators	Wall cracked badly during last test.
9	Muhamdi, ..	7' 6"	11' 8"	31' 2"	27' 7"	Sand	Sand and kunkur	906	12	1	700	0	0	Bond, Ghulam Chisti Khán	Tested by Engineer—sand came in
10	Hayatpur, ..	8' 1½"	12' 8"	33' 8"	27' 5"	Sand	Sand and kunkur	966	0	4	400	0	0	" " "	Do. do.
11	Majhola, ..	8' 2"	12' 0"	22 8"	10' 0"	Clay	Clay	715	6	10	600	0	0	Crop rates.	A good well.
12	Baldana, .	6' 0"	5' 5"	27' 7"	30' 0"	Sand	Sand and kunkur	518	3	4	400	0	0	Bond, Ghulam Chisti Khán	Not tested
13	Chak Dhanori,	6' 0"	9' 0"	30' 0"	55' 10"	Concrete	Sand	586	15	11	400	0	0	Bond, from cultivators	Under experiment
14	Rajohan I, ..	6' 0"	12' 0"	30' 0"	4' 0"	Clay and ballast	Clay	385	12	0	400	0	0	" " "	Good well
15	Rajohan II, ..	6' 0"	10 3"	31' 3"	36' 0"	Ballast	Sand and kunkur	404	15	6	400	0	0	" " "	Tested—sand came into cylinder
16	Bawan Kheri I,	5' 0"	10' 0"	31' 3"	64' 0"	Ballast	Sand and stone	448	12	5	400	0	0	" " "	Do do.
17	Bawan Kheri II,	5' 0"	10' 1"	31' 2"	44' 0"	Ballast	Sand and kunkur	440	1	7	400	0	0	" " "	Do. do
18	Bahadurpur, ..	6' 0"	10' 4"	31' 6"	27' 1"	Ballast	Sand and kunkur	411	15	7	400	0	0	Crop rates	Do. do.
19	Dehri Jat I, ..	6' 0"	9' 3"	32' 3"	28' 0"	Ballast	Sand and kunkur	512	4	8	400	0	0	Court of Wards.	Do. do.
20	Dehri Jat II, ..	6' 0"	9' 6"	31' 0"	55' 9"	Ballast	Sand and kunkur	477	8	4	400	0	0	Court of Wards.	Do. do.
21	Rampur, ..	8' 2"	23' 1"	43' 8"	51' 6"	Sand	Sand and kunkur	1,136	10	2	700	0	0	Bond, Ghulam Chisti Khán.	Never tested—on high sandy ridge.
22	Manota, ..	6' 0"	14' 0"	32' 10"	16' 4"	Sand	Clay and kunkur	408	11	6	450	0	0	Paid by Mr Alexander (369-5-0).	Clay stratum 9" thick—never tested

TABLES AND APPENDICES TO CAPTAIN CLIBBORN'S REPORT.

TABLE A.—*Observation and Experiment*

STATISTICAL.

Serial Number	Locality: Province	Locality: District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Area in Acres: Percentage uncultivated: Waste	Area in Acres: Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Cultivated Area: Double cropped area in acres	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Percentage of Total Cultivated Area: Dry	Kharif: Wet: Wells	Kharif: Wet: Canals	Kharif: Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi: Wet: Wells	Rabi: Wet: Canals	Rabi: Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Irrigation Wells: Dry bricks	Irrigation Wells: Kacha	Irrigation Wells: Total	Lifts: Leather bucket	Lifts: Earthen pots	Lifts: Total	Usual labor for lifting buckets	Average area per lift, in acres: Kharif	Average area per lift, in acres: Rabi	Average area per lift, in acres: Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
2		CAWNPORE.	Jájmau,	Bidnu,	1879 80	879 (	26 5	28 1	45 4		396·0	34 0	66 0											9		26	35	35	Nil	35	Bullock			3·5	No. of lifts doubtful.
3			"	"	80-81	879 (	26 5	36 0	87 5		329 8	55 0	45 0											7	5	27	39	39		39	"		..	4 6	" " "
5			"	Khirsa,	79 80	1086 (	31 2	17 5	51 3		5o7 1	30 4	69 6													68	63	63		68	"			2·6	
6			"	"	80 81	1086·4	31 2	23 0	45 8		498 6	39 3	60 7													72	72	72		72	"			2 7	
4			"	Chachendi,	80-81	4347·7	10 0	20·0	40 0	Nil.	1738 2	40·0	51 0	5 4	0·4		39 6	45 4	27 5	15 5	0 2	11·4	54·6	2 p-19		1 p-57					"	0 4	2 2	2 6	
																								4 p- 9		2 p-40	125	211		211	"				
9			"																																
11			"	"																															
12			"	"																															
13			"	"																				..	..						..				
16			Ghátampur,	Gatchapur,	79 80	1533·02	20·1	21 6	58 3	74	955 6	5 5	94 4	0 4			42 7	48 1	4 5	0 7		51 7	56 9	4 p- 5 2 p- 9	..		14	38		38	"	0 1	1 2	1 3	
17			"	"																															
18			Bhognipur,	Bhognipur,	79 80																										"				
20			Akbarpur,	Niganjassi,	80 81	948 8	49 3	5 8	44 0	1 5	427 5	47 2	52 8	0 8	16 8	0 5	23 0	40 6	0·4	29 0		30 0	59 4	1			1	1		1	"	3 35	1 97	5 32	
21			"	Jalalpur,	89 81	1615 4	23 9	20·7	55 4	58 2	953·0	47 2	53 8	0 6	20 6		20·6	41 8	1 9	23 7	0·4	32 2	58 2	4		1	5	11		11	"	0 5	1 6	2 1	
528			Bithúr,	Bithúr,	79 80	2398 0	14 0	16 4	69 6	286 5	1955·0	13·0	82 0	0 5		0 4	40 0	40·0	3 1		0 0	42·0	59 1	1 p- 3 2 p- 3	1 p-10	1 p-51	67	70		70	"	0·11	2 27	2 38	
530			"	"	80 81	2398 0	14 3	15 7	70 0	143 3	1822·0	26 9	73 1	0 8		0·4	41 1	42 3	11 2		14 5	33 0	57 7	1 p- 3 3 p- 3	1 p-10	1 p-46	62	65		05	"	0·20	3 15	3 35	In 81 82 many wells failed.
24		HAMIRPUR.	Somerpur,	Somerpur,	79 80	9830 3	3 7	14 7	81 6		8024·0	0 10	99 9	07			52 5	52 57	03			47 4	47 48	8			8	9		9	"	0 68	0 82	1·00	
25			"	"	80 81	9830 3	3 8	60 6	35 6		3502·0	0·36	99 64	0·8			66·8	66 88	28			32 84	38 12	8			8	9		9	"	0 32	1 12	1·44	
26			Maudha,	Maudha,	79 80	6482 7	11 2	20 6	68 2		4425 0	0·74	99 26	02			x	x	72			x	x	16			16	18		18	"	1 30	0 1	1 90	
27			"	"	80 81	6482·7	11 2	20 7	68 1		4417 5	0 48	99 52	10			x	x	38			x	x	16		..	16	18		18	"	0 9	0 16	1 00	Only 4 spring wells.
29			Mahoba,	Bugwa,	79 80	2613 5	10 5	38 5	51 0		1347 0	1 2	98 8	0 5	..		57 9	58 4	0·7		..	40 9	41 6	10	..	..	10	10		10	"	0·7	0 9	1·6	Rock wells
30			"	"	80-81	2613 5	10 5	38 6	50 9		1335 7	1 3	98 7	0 3			55 0	55 8	1 0			43·7	44 7	10			10	10		10	"	0 4	1·3	1 7	" "
31			"	Mahoba,	79 80	3882 8	29 2	38·2	32 6		1266 1	8 76	91 24	0 01	0·05		63 64	63·7	2 7	5 6	0 4	27 6	36·3			..	32	34		34	"	0 04	1 0	1 04	Tank fed wells.
32			"	"	80 81	3882 8	28 9	37 3	33 8		1313 1	7 00	93 00	0 65	0 55		64 3	65 5	5 6		0·2	28 7	34 5				32	34		34	"	24	2 2	2 44	" "
34			Panwári,	Kulpahár,	79-80	12039 2	22 7	35·0	42 3		5091 3	0 7	99 3	0 1			75 6	75 7	0 6			23 7	24 3	34		11	45	34	11	45	"	0·14	75	90	" "
35			"	"	80 81	12039 2	22 4	34 0	43 5	60 5	5298·8	0 91	99 09	0 01			67 5	67 5	0 9			31 6	32 5	34		11	45	34	11	45	"	0 02	1 05	1·07	" "

TABLE A.—*Observation and Experiment*—(Continued).

DESCRIPTIVE.																								
	Date				*Class*	*Cost*							*Supply.*	*Quality*	*Substratum*	*Cultivators on well*		*Labor and cost per day in annas*						
Serial Number.	Day	Month	Year	Number of Well.		Construction.	Fittings.	Total.	Renewal.	Lifts.	Yearly repairs.	Total.				Number	Caste	Men, home.	Do. hired	Rate, per day	Cattle	Cost for men.	Do. for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
2	22	11	81	431	Dry brick,	200/	8/-	208/		7/	1/	11/	Spring,	Sweet,	Clay,	1	Ahir,	4			5	3·0	7 5	-/10/6
3				587	Kacha lined,	20/-	4/	24/		5/-	1/-	12/	Percolation,	"	Sand,	2	"	3	.	.	2	2 0	3·0	/5/-
5	.			.	" "	16/	5/	20/	1/8	5/-	2/-	8/8	"	"	"	1	"	3	..	.	2	2·0	3·0	/-/-
8	17	12	81	2,848	" "	22/	8/	30/-	5/	5/	4/	19/-	Spring,	"	Clay,	2	Brahmin,		4		4	0 0	6·0	/12/
9			.	2,846	" "	22/	8/-	30/	5/-	5/	4/	19/	"	"	"	2	Chamar,	4	.	.	4	3·0	6·0	-/9/-
11				2,81?	" "	22/	8/	30/-	5/	5/	4/	19/-	"	"	"	2	"		4	.	1	6·0	6·0	/12/-
12			.	2,861	" "	22/-	8/	30/	5/	5/-	4/	19/	"	"	"	2	" & Thakur,	4		.	4	3·0	6 9	/3/-
13		.	.	3,077	Masonry,	300/	12/-	312/	.	5/	1/	16/	"	"	"		Kachi,	5		.	6	4 0	9 0	/13/-
16	23	11	81	400	" 2 pur,	200/	4/-	204/	..	5/	1/-	6/	Percolation,	"	Sand,	1	Kurmi,	3	..	..	3	2 0	4 5	/6/6
17				.	" 4 pur,	300/	4/-	304/	.	6/	1/	6/-	"	"	"	1	Mahajan,		3	..	2	4 5	7·0	-/17/6
18	14	12	81	218	Masonry, old bad,	300/	2/	302/		3/		9/	Spring,	"	Clay,	1	Kachi,	?	.		2	2 0	3 0	-/5/-
20	16	12	81	.	" "	200/-	6	206/	.	6/-	1/	7/	"	"	"	1	Ahir		3	1 2?	2	3 75	3	/6/9
21	.	.		705	" "	400/	24/	424/		6/	1/-	2?/	"	"	"	?	Chamar,	4	.		4	3	6	-/3/-
22													"	"	"	?	"	4			4	3	6	/9/-
328	10	4	82	80?	Kacha, lined with wood,	25/-	4/-	29/-	..	5/	1/-	6/	"	"	Clay 75,	3	Kachi,	?	1	2 0	3	3	3	-/6/-
																1	Herd man,							
533	16	4	82	859	" "	25/	4/-	29/-	..	7/-	1/	6/	"	"	"	1	Kachi,	3			2	2	3	/3/-
																1	Kurmi,							
24	26	11	81	.	Masonry,	210/	4/-	214/		3/	1/	4/	"	"	"	1	Kachi,	?	.	.	4	2	3	-/8/
26	27	11	81	3,850	"	300/-	6/-	306/	.	4/	1/	9/-	Percolation,	"	"	?	"	4	..	..	4	?	6	-9/
27	.				"	300/-	3/-	303/	..	4/	1/-	5/	"	"	"	1	"	0		..	2	2	3	/-/
29	20	11	81	340	"	200/	3/-	203/-	.	4/	1/	5/	"	"	Rock,	2	"	3		..	2	2	3	-/5/
31	30	11	81	1,416	"	200/	9/	209/	..	3/	1/-	4/	"	"	Gravel,	1	"	3	.	..	1	3	6	/8/-
32	1	12	81	1,050	"	250/-	7/-	2?0/		4/	1/	5/	"	"	"	3	"	4	.	.	4	3	6	/8/-
33	2	12	81	.	"	200/	3/-	203/	.	4/	1/	5/	"	"	"	1	"	3		..	2	3	3	/5/
34	4	12	81	99?	"	100/	8/	107/-		3/	1/	4/	"	"	"	1	"	3	.	..	2	2	3	/4/
35	4	12	81	3,001	Kacha,	5/	3/	8/-	old,	3/	1/-	4/-	"	"	"	4	"	3	..	..	4	2	3	/5/

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL. Run: Class	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil.	COMMAND. Kharif 1881 82: Crop	Kharif: Waterings required.	Kharif: Area.	Kharif: Total area reduced to one watering.	Kharif: No. of days to area.	Rabi 1881 82: Crop	Rabi: Waterings required	Rabi: Area.	Rabi: Total area reduced to one watering	Rabi: No. of days to area.	AREA IRRIGATED TO DATE. Kharif 1881-82: Crop	Kharif: Waterings given.	Kharif: Area.	Kharif: Working days to date.	Kharif: Duty: Per lift.	Kharif: Duty: Per pair	Rabi 1881 82.: Crop	Rabi: Waterings given.	Rabi: Area	Rabi: Working days to date.	Rabi: Duty: Per lift.	Rabi: Duty: Per pair
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
2	Lagor,	1 25	2	3·00		42		Dumat,	Cotton,	2	3·2	6 4	63	Wheat & Barley,	3	3 5	10 5	103												
7	"	1	1			38		"	"	2	1 6	3 2	59	Wheat,	3	3·3	9 9	183												
8	"	1	1		38			"	"	2	1 85	8·7	76	Wheat,	3	2 65	7 95	163												
8	"	1	2				32	"	"					Wheat, Opium,	4	3 85	15.4	93												
9	"	1	2				86	"	"					Opium, Wheat & Barley,	5 2	1 22 2 45	12 8	74												
11	"	1	2				37	"	"					Wheat,	3	1 00	8·0	48												
12	"	1	2				37	"	"					Wheat,	3	3 50	10 5	84												
13	"	1	3				35	"	"					Opium, Wheat, Bajhra,	6 3 2	2 90 2 23 3 45	31·00	78												
16	"	1 5	1		20			Matyar,	"					Gujai,	2	3 1	6 2	87												
17	"	1	1				42	"	"					"																
18	"	1	1	1 875	91	94	92 5	Dumat,	"					Vegetables,		Small,														
20	"	1	1	2 925	15	16	15 5	"	"					Wheat,	2	1 5	3 0	87												
21	"	1	2	2 6	16	23	19 5	"	Cotton and Indigo	2	4·0	8·0	22	Wheat & Barley,	2 5	12 2	30 5	85									Nil			
22	"	1	2	2 6	16	23	19 5	"	"																					
528	"	1	1	2 64	17	50	48 5	"	"					Potatoes, Tobacco, Garden, Wheat,	12 12 10 4	0 5 1 0 1 6 1 5	40	224							Potatoes, Tobacco, Garden, Wheat,	12 12 8 4	0 5 1 0 1·6 1·5	24 60 56 24	0 250 0 200 0 228 0·250	0 250 0·200 0·228 0 250
533	"	1	1	2 59	48	57	52 5	"	"					Tobacco, Potatoes,	12 12	1 7 1 7	40 8	216							Tobacco, Potatoes,	10 12	1 7 1·7	65 78	0 261 0 261	0 261 0·261
24	"	2	1				85	Parwa,	"					Opium,	5	3 0	10 0	320							Paleo,	1	0 2	7	0 081	0·081
26	"	1	2	3 0	30	40	36	"	"					Opium,	5	4 50	22·8	250 8*							Paleo,	1	0·72	8	0·045	0·045
27	"	1	1		21			"	"					Do. & Vegetable,	10	0 90	9·0	69·3							Opium, Vegetables,	x	0·90	7	0·130	0 130
29	"	1	1	3 0	20	23	21 5	Rakur,	Cotton,	2	2·6	5 2	20·8	Vegetables,	10	2 6	26·0	100							Vegetables,	x	2·6		0·136	0 136
31	"	2	1	1 65	16	28	22	Parwa,	"					Tobacco,	7	2 88	19·8	79 2							Tobacco,	x	2 88		0 327	0·163
32	"	1	2	2 4257	20	28	27·5	"	"					Tobacco,	10	4 00	40·0	102							Tobacco,	2	4 00	11	0·18	0·18
33	"	1	1	2 836	29	35	32	"	"					Tobacco,	10										Tobacco,	2				
34	"	1	1	2 06	10 5	14	12 2	"	"					Barley,	6	2 0	12·0	63·6							Barley,	1	2·0	8	0 25	0 25
35	"	1	1	1 5	19	20	19 5	"	"					Barley,	6	4·7	28 2	197 4							Barley,	1	0·6	4¼	0 148	0 148

* No Kyaries

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number.	Duration of work minutes.	No. of lifts.	Cubic feet lifted: Per pair of cattle per hour	Cubic feet lifted: Per lift, per hour.	Cubic feet lifted: Total per well.	H P: Per bullock.	H P: Total per well.	Length of water course.	Area Irrigated: Crop	Area Irrigated: Watering	Area Irrigated: Interval.	Area Irrigated: Area in square feet	Depth: On area.	Depth: Of damp	Days to an Acre: Per pair of cattle.	Days to an Acre: Per lift.	Days to an Acre: Per well.	Duty per pair	Cost, Annual: Interest at 5 p. c.	Cost, Annual: Repairs, &c	Cost, Annual: Total.	Cost: Per acre Irrigated.	Cost, Per Acre: Lifting	Cost, Per Acre: Total.	Remarks
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
2	400	430	77 4	193 7	1,200	878	351	200	Wheat,	1	.	4 410	292		21 5	19 6	9 8	..	10 4	11·0	21 4	3 0	10 2	21 2	Wheat.
3	.			.	.	.		100	Paleo,	1		2,380	.	.	18 5	18 5	18 5	..	1 2	12·0	13 2	2 0	17 4	20 0	"
5	.						.		Wheat,	1		2,100		..	20·7	20 7	20 7	.	1 0	8 5	9·5	2 1	10 4	21 5	"
8		.	.				.	.	Mixed, .	1	.	7,300	-		12 0	12 0	6 0		1 5	10 0	20·5	3 5	18 0	21 5	"
9				.		.	.		Mixed,			7,404		.	11 6	11 6	5 8		1 5	10 0	20 5	8 7	{ 16 3 6 5	20 0 10 2	Opium Wheat and Barley
11							.		Wheat,	1	.	5,176		.	16 0	16 0	8 0	..	1 5	10 0	20 5	14·7	18 0	32 7	Wheat.
12	..								Wheat, .	1		5,500			16 0	16·0	8 0		1 5	10 0	20 5	3 8	13 5	17 3	Wheat.
13	..		.		..				Opium, .	1	..	17,700	..		7 5	7 5	2 5	..	15 6	10·0	31 6	2 4	12 0	14·4	Opium
16	..		.		.	.	.		Closed will resume		.	3,000			21 5	14 3	14 0		10 2	0·0	10 2	3·4	11 4	14 8	Gujai
17		.			.				Opium,	1	.	4,000	.		11 0	11 0	11 0		15 2	0 0	21 2		23 4		Opium
18	460	203	50 0	50·0	380	1 36	028	100	Vegetables,	x	3 days,	4,752	09	.	9 0	9·0	9 0	.	15 1	3 0	18 1		28 0		Vegetables.
20	540	390	120·0	120·0	1,140	520	281	400	Wheat,	1		1 108	00		29 0	29 0	29 0	.	10 3	7 0	17 3	7 5	24 4	31 9	Wheat.
21	{ 580	776	114 2	114 2	} 4,084	700	360	300	" .	1	.	15 765	128		5 5	5 5	2 8	} .	21 2	25 0	46 2	2 8	{ 4 7	7 5	{ Wheat { Cost calculated at 14 days per acre for three days' work.
22	{ 530	776	114 2	114 3				1,150	"	1		1,442			60 0	60·0	30 0						3 3	6 0	{ Barley
528	527	381	115	115	1,014	1 567	820	270	{ Tobacco, Garden,	12 8	12 days,	7,550	13	75	5 6	5 6	5 6	.	1 5	6·0	7 5	1 1	{ 25 2 25 2 16 8 8 1	20 7 20 3 17 9 0 5	Potatoes. Tobacco Garden Wheat.
533	530	450	133	133	1 181	2 001	1,110	160	Tobacco, .	10	12 days,	8,165	14	70	5 3	5 3	5 3		1 5	6 0	7 5	1 1	{ 19 0 19·0	20 4 20 4	*Tobacco* Potatoes
24	480		.		.			1,000	Paleo,	1	.	1,357	.		32 0	32 0	32 0	..	10 7	4·0	14 7	4 9			Cannot be calculated
26	.	.		.			..	100	Paleo, .	1		3,020	.	.	22 0	22 0	11 0		15 3	9·0	24 3	8 9		.	
27		..	..				..	100	Opium,	x		5,689		..	7 7	7 7	7,7		15 2	5 0	20 2	13 4	23 0	30 4	Opium
29	105	125	214	214	375	1 285	175	350	Vegetables,	x	.	2,700	130		15 0	15 0	15 0		10 2	5 0	15 2	2 0	{ 47 0 0 4	49 0 12 3	Garden Cotton
31	$275\frac{day}{2}$	414	74 55	149·1	083	580	160	200	Tobacco, .	x		5,705	110		8 0	4·0	4 0		10 2	4·0	14 2	3 3	14 0	17 3	Tobacco
32	453	1,009	102·0	102·0	2 447	1 117	507	50	"	2	..	17,020	148	.	5 12	5 12	2 56		12 8	9 0	21 8	3 0	12 8	16·4	"
33	405	438	160·0	160 0	1 285	1 570	714	250	"	2		7 551	170	.	5 77	5 77	5 77	,	10 2	5 0	15 2		18·0		"
34	410	558	167	167	1,130	620	252	150	Barley,	1	.	8,280	187		5 3	5 3	5 3		5 2	4 0	9 2	3 1	0 6	12 7	
35	380	557	130	130	835	717	270	130	Barley,	1		6,020	138	0 06	7·0	7·0	7·0	.	0 4	4 0	4 4	0 6	18 2	18 8	

TABLE A.—*Observation and Experiment*—(Continued)

STATISTICAL.

Serial Number	Province	District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Percentage uncultivated: Waste	Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Cultivated Area: Double cropped area in acres	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Dry	Kharif: Wet: Wells	Kharif: Wet: Canals	Kharif: Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi: Wet: Wells	Rabi: Wet: Canals	Rabi: Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Dry bricks	Kacha	Total	Lifts: Leather bucket	Earthen pots	Total	Usual labor for lifting buckets	Average area per lift, in acres: Kharif	Rabi	Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
36	U. P.	HAMIRPUR	Panwári, .	Deoganpura,	1879 80	1026·0	5 85	10 41	83 74	.	859 1	0·03	99 97	0 03	..		34 97	35 0	.	..	..	65 0	65 0	5	..	.	5	5	.	5	Bullocks,	0·05	..	0·05	No kacha wells.
37			" ..	"	80 81	1026·0	5 68	11·00	83 32	..	854 6	0·30	99·70	0 96		.	28 70	28·76	0 24	.		71 0	71 24	5	..	..	5	5		5	"	0·10	0 41	0 51	
38			" .	Panwári,	79 80	2810·2	7 39	12 70	79 91		2245 4	1 03	98 97	0 51		.	38·48	38 99	0·52			60 49	61 01	13	..	..	13	13		13	"	0·9	0 9	1 8	
39			" ..	"	80 81	2810 2	7 38	13·98	78 64	53 8	2263 5	0 80	99 20	0 10	..	.	39 00	39 10	0 70	.	..	60 20	60 90	13	.	..	13	13		13	"	0 13	1 2	1 33	
40			" .	Alipura,	80-81	253 15	4 99	25 90	69·20	0 88	176 03	1 65	98 35	0 23		.	35 72	35 95	1 42		.	12 63	14·05	1	.		1	1		1	"	0 04	2 40	2·53	Only well in village
41			Jaitpur, .	Morari,	79 80	4554	35 0	31 6	33 4		15·26	6 56	93 14	0 39	.		70 10	70 49	3 45	.	2 72	17 34	23 51	..	..	..	35	47		47	"	0 13	1 17	1 30	
42			" .	"	80 81	4554	34 8	30 02	35 18	..	16 02	7 22	92 78	0 29			67 66	67 95	4·07	1 26	1 60	25 12	32 05	.			35	47		47	"	0 12	1 30	1 42	
43			" .	Jaitpur,	79 80					..														130	.	..					"	.	1 77		Tank fed wells.
45			Ráth, ..	Ráth,	79 80	7875	9 37	25 37	65 26	..	51 41	3 34	96 66	1 43			31 58	33 01	1 91		..	65·08	66 99	24	..	23	47	53		53	"	1 20	1 85	3·05	
46			" ..	"	80-81	7875	9 37	24 25	65 88	..	51 90	2 97	97 03	1 29			37 12	38·32	1·77	.		59 91	66 68	10	..	14	33	39		39	"	1 60	2 35	3 95	
58			Ráth, .	Juroya,	82 83	.	..	..			.			.				.	..	.		.		4	..	..	4	6		6	"	..	30	0 30	In these villages the buckets are used also to fill vessels for drinking purposes
59			Jalálpur, .	Chandaut,	82 83	.	.	.		.			.	..				.		.	.	.		4			1	5	6		6	"	..	·18	.	
63		FARRUKHABAD	Kanauj, ..	Mirán ki Sarai	79-80 81 82	423·0	13 8	10 5	75 7	105 97	426 0	57 6	42 4	12 7			31 6	44 3	44·9		.	10 8	55 7	2	.	187	189	140	.	140	"	0·38	1 36	1 74	
69			Chibrámau, .	Gurshahiganj,	79 80	745·91	16 1	8·6	75·3	73 67	635 64	49 0	51 0	0 7		.	44 2	44 9	47 8	.	0 5	6 8	55 1	.	.	187	187	171	.	171	"	0 02	1 8	1 82	
70			"	"	80 81	745 91	16 2	8 6	75 2	86 80	647 86	68·3	31 7	13 3	..		27 0	40 8	55 0	.	..	4 7	60 0		.	183	183	167	.	167	"	0 51	2 18	2 64	

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well	Class	Cost: Construction	Cost: Fittings	Cost: Total	Cost: Renewal	Cost: Lifts	Cost: Yearly repairs	Cost: Total	Supply	Quality	Substratum	Cultivators on well: Number	Cultivators on well: Caste	Labor: Men, home	Labor: Do. hired	Labor: Rate, per day	Labor: Cattle	Cost for men	Do. for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
36	6	12	81	231	Masonry,	250/	3/	253/		3/	1/	4/	Percolation,	Sweet,	Gravel,	1	Kachi,	3		..	2	2	3	/5/
37				60	"	250/	3/	253/		3/	1/	4/	"	"	"	1	Lodhi,	3			4	2	6	-/8/-
38				..	"	150/	3/	153/		3/	1/	4/	"	"	"	1	Kachi,	3		..	2	2	3	/5/-
39					"																			
40				[illegible]	"	200/	3/	203/		3/	1/	4/	"	"	"	1	"	3			2	2	3	-/5/
41	5	12	81	1307	"	150/	6/	156/		3/	1/	7/	"	"	Rock,	1	Brahmin,	4		..	4	3	6	/9/-
42	5	12	81	746	"	150/	6/	156/		3/	1/	7/	"	"	"	2	Kachi,	4			4	3	6	/9/-
43	5	12	81		"	100/-	0/	100/		3/	1/	7/	"	"	Gravel,	2	Brahmin,	4			4	3	6	/9/-
45	7	12	81	727	"	250/	8/	258/		3/	1/-	4/	"	"	"	7	Kachi,	3			2	4	3	
46				[illegible]	"	300/	6/	306/		3/	1/	7/	"	"	"	1	"	4			4	3	6	/14/
47	8	12	81		"	200/	3/	203/		3/	1/	4/	"	"	"	1	"	3		..	2	2	3	/5/
48					Kacha,	11/	4/	15/	9/	3/		15/	"	"	"	1	Ahir,	4			4	3	6	/9/
49					Masonry,	150/	0/	150/		3/-	1/	7/	"	"	"	1	Musalman,		4		3	6	12	1/2/
50				202	"	250/	3/	253/		3/	1/-	4/				4	Kachi,	3		..	2	2	3	
51				199	"	300/	6/	306/		3/	1/	7/				12	"	4		..	4	3	6	
52				170	"	300/	6/	306/		3/	1/	7/	"	"	"	0	"	4			4	3	6	1/12/
53				168	"	250/	3/	253/		3/	1/	4/				1	"	3			2	2	3	
54				227	"	300/	6/	306/		3/	1/	7/				21	"	4		..	4	3	6	
55				117	"	300/	0/	300/		3/	1/	7/				9	"	4			4	3	6	2/
56				[illegible]	"	300/	0/	300/		3/	1/	7/	"	"	"	6	"	4			4	3	6	
57				102	"	250/	3/	253/		3/	1/	4/				2	"	3			2	2	3	
58	9	12	81		"	400/	6/	406/		3/	1/	7/	"	"	"	1	"	4			4	3	6	-/9/
59	10				"	500/	3/	503/		2/	1/	3/	"	"	"	1	"	3		..	2	2	3	/5/
60					"	500/-	0/	500/		2/	1/	5/	"	"	"	1	"	4			4	3	0	/9/-
61	11			1178	"	300/	3/	303/		2/	1/-	3/	"	"	"	3	Lodhi,	3			2	2	3	-/5/
62	0	1	82		"	300/-	0/	300/		5/	1/	11/	Spring,	"	Clay,	3	Brahmin,							
																4	Kurmi,	3	1		4	3 0	6	/9/6
																2	Chamar,							
66					Kacha unlined,	1 75	4/	5 75		10/	1/	21/	"	"	"	1	Kurmi,	1	2	..	2	3	3	-/6/
67				6 wells	" "	10 5	24/	34 5	..	10/-	7/	17/	"	"	"	a	"	12			14	11	21	2/
69	10	1	82		" "	4/	3/	7/		10/	1/	11/	"	"	"	3	Thakur,							
																2	Kachi,	2	3	..	5	5 5	7 5	-/13/
																2	Chamar,							
72	10	1	82		" "	4/	2/	6/		10/	1/	11/	"	"	"	0	Thakur, Kachi,	3			2	2	3	/5/

TABLE A.—*Observation and Experiment*—(Continued)

EXPERIMENTAL.

Serial Number	Run: Class	Run: Pairs of cattle to each lift	Lift: Number	Lift: Content in cubic feet	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean	Soil	Command, Kharif 1881 82: Crop	Waterings required	Area	Total area reduced to one watering	No. of days to area
	62	63	64	65	66	67	68	69	70	71	72	73	74
36	Lagor,	1	1	..	37	40	38·5	Parwa,	Sugarcane,	4	.	..	.
37	"	3	1	..	41	..	..	"	"	4	1 73	6 92	65
38 39	"	1	1	..	36	.	.	"	"		..		
40	"	1	1	.	37	.		Rakur,	"				.
41	"	1	2		11	17	14	Parwa,	"	.	1 8		
42	"	1	2	..	12	20	16	Rakur,	"				.
43	"	1	2	..	10	18	14	"	"	.			
45	"	1	1	..	.	49	45	Parwa,	"				.
46	"	1	2	..	42		46	"	"	.			.
47	"	1	1	2 7	27	45	36	"	"				.
48	"	1	2	.	18		.	Rakur,	"	7	3·0	21 0	126
49	"	3	2	..	18			Parwa,	"	8	1 75	14 0	95
50	"	1	1		27	49	39	"	"				
51	"	1	2	..	27	48	37 5	"	"				
52	"	1	2		30	46	37 5	"	"			..	
53	"	1	1	.	25			"	"			.	.
54	"	1	2	.	30	54	42	"					
55	"	1	2		34	48	41	"	"	.	..	..	
56	"	1	1	..	37	54	45 5	"					
57	"	1	1	..	30	48	39	"					
58	"	1	2	.	88		.	"	"		.	.	..
59	"	1	1	1 7	113	.	.	"	"		.	..	..
60	"	1	2	..	111		..	"	"				
61	"	1	1	.	57		.	Clay,	"	4	2 27	9·08	120
63	"	1	2	3·15	56	61	58 5	Dumat,	"			.	
66	"	1	1	2 95	54	60	57	"	"		..	.	
67	"	1	7		61	71	66	"	"			..	.
					Average								
69	"	1 25	2	2 7	46	.	.	"	"	..	..	..	..
72	"	1	1	3 6	44	50	47	"	"	..	..	..	

Serial Number	Command, Rabi 1881 82: Crop	Waterings required	Area	Total area reduced to one watering	No. of days to area	Area irrigated to date, Kharif 1881 82: Crop	Waterings given	Area	Working days to date	Duty: Per lift	Duty: Per pair	Area irrigated to date, Rabi 1881 82: Crop	Waterings given	Area	Working days to date	Duty: Per lift	Duty: Per pair
	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
36	Opium,	10	2 1	21 0	105·0	..	.		.	.		Opium,	4	2 1	40	0 21	21
37	Vegetables,	10	0·9	9 0	84 6	Sugarcane,	4	1 73	65	0 10	0 05	Vegetables,	x	0 9	x	.	..
38 39	Tobacco, Opium,	10	3·5	35 0	110	"	.		.			Tobacco, Opium,	x	3 5	x	·29	29
40	" Vegetables,	10	1 3	13·0	150	"		.				" Vegetables,		.	..	08	0 8
41	Barley,	5	3 4	14·0	113	"				..		Barley,	1	3 4	21	06	0 6
42	"	6	2 6	15·6	23 4	"					.	"	1	2 6	4	0·325	0 325
43	Daud Wheat,	3	3 6	10·8	69	"	..			.	.	Wheat,	1	2 95	19	0·775	0 775
45	Tobacco,	5	9 9	49 5	135	"				.	.	Tobacco,	x	9 9	28	1·176	1 176
46	"	5				"		.	.			"			..		
47	"	5	3 4	17 0	112	"						"	x	3 4	25	135	·135
48	"		.			"	4	3	72	085	085	"	.			.	..
49	"			.	.	"	8	1	96	072	·036	"	..	.		.	.
50	"	7				"	.					"	x				
51	Opium,	7	1 4	98	183	"			.		.	Opium,		14	26	09	0·9
52	Vegetables, &c.	7				"	.	..		..	.	Vegetables, &c		.	.	.	.
53	"	7				"	.				.	"	.		..	..	.
54	Tobacco,	7															
55	"	7	3 7	259	888	"		.		..	.	Tobacco,	..	..	..	..	..
56	"	7															
57	"	7															
58	Opium and Vegetables,	7	0 32	2 24	33	"			.			Opium and Vegetables,	x	0 52	6	027	027
59	Opium,	10	0 15	1 50	204	"	.	.				Opium,	x	0 150	12	·012	012
60	"	10	0 24	2·40	208	"	.					"	x	0 240	12	·014	014
61	"		.		.	"	2	2 27	60	075	·075	"	.		..	..	..
63	Barley, Wheat, Opium,	2 3 6	7 23 1 23	20 55	123 3	"	.		..			Barley, Wheat, Opium,	1 1 x	7 23 1 23 0 4	60	0·074	0·074
66	Wheat and Barley,	3	2 11	6·33	53	"		..			..	Wheat and Barley,	1	3 11	x	0 117	0 117
67	Barley, Wheat,	1 2	30 3 5·6	41 5	79	"			..			Wheat, Barley,	1 1	5 6 11 0	60	0·05	0 05
69	Barley, Wheat, Opium,	2 3 6	1·48 4 26 2 00	28 0	123 2	"	.	.	.		.	Barley, Wheat, Opium,	1 1 2	1 43 4 26 2 06	7 5 21·0 10·0	0 095 0 100 0·206	0 076 008 0 164
72	Barley, Opium,	2 7	2 66 1 26	14 14	187	"	.	.	.	..	.	Barley, Opium	1 2	2 66 1 26	22 0 20 0	0 120 0 126	0 120 0 126

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number	Duration of work minutes.	No. of lifts	Cubic feet lifted: Per pair of cattle per hour	Per lift, per hour	Total per well.	H P: Per bullock.	Total per well	Length of watercourse.	Area Irrigated: Crop	Watering	Interval.	Area in square feet.	Depth: On area.	Of damp	Days to an Acre: Per pair of cattle	Per lift.	Per well.	Duty per pair	Cost, Annual: Interest at 5 p c.	Repairs, &c.	Total.	Per Acre: Per acre Irrigated.	Lifting	Total	Remarks
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
36	...		..	.	..		.		Opium,	5	...	9,147			5 0	5·0	5 0		12 6	4·0	16 6	5 0	15 0	20 6	Opium
																							6 2	11 2	Sugarcane
37	.		.		.		..	..	Sugar,			4,011			9 4	9 4	9 4		12 6	4 0	16 6	0 0	18 8	24 8	,,
38									{ Tobacco, Opium, }	.		12,753			3 4	3 4	3 4	..	7 7	4 0	11 7	2 2	10 0	{ 12 8 12 8	Tobacco Opium
40			..		..			500	Opium,		...	3,610	..	...	12 0	12 0	12 0		10 1	4 0	14 1				
41					.	...		300	Barley,	1	.	5,272	.		10 0	10 0	8 0		7 8	7 0	14 8				
42	..						.	200	,,	1	.			.	3 0	3 0	1 5		7 8	7 0	14 8				
43		..						150	,,	1		6,787	.		12 8	12 8	0 4		5 8	7·0	12 8				
45			.					50	Tobacco,	x		5,303			8 2	8 2	2 73	}	28·0	11·0	39 0				
47	440	424	157	157	1,145	1 889	828	250	,,	x	.	6,500	174	.	6 6	6·6	6 6		11 5	4·0	15 5				
48							.	200	Sugar,	2	.	3,010			12·0	12 0	0 0	.	7	15 0	15 7				
49				.		.		250	,,	2	..	6,352			27 2	13 6	6 8	.	7 8	7·0	14 8				
50	..	..	.				.	.	Tobacco,	x	..	{ average of 10 measurements			11·17	11 17	}								
51			,,		,,	.			Opium,						11 17	11 17	1 86		50 0	22·0	78 0				
52			.		.				Vegetables,						11 17	11 17									
53	.	.		.	.		.		,,		.	23,400			11 17	11 17	}								
54																									
55	.			.	...	.	.	.	,,			28,000			10 8	10 8	1 5	.	58 0	25 0	83 0				
56																									
57																									
58			.					100	{ Opium, Vegetables, }	x		2,909		.	30	30	15		20 8	7 0	27 8				
59	300 $\frac{days}{2}$	118	40	40	$\frac{47\ 1}{155\ b}$	1 465	870	100	Opium,	x	...	160	21		13·6	13 6	13·6	.	26 5	3·0	29 5				
60	.		.			..			,,	x	.	1,500	.		87	87	43		30 8	5 0	35 8				
61				.					Sugar,	2	.	3,206	..		13·2	13 2	13 2		15 1	3·0	18·1				
63	500	370	72·0	72 0	1,184	1 160	580	510	Barley, ..	1	.	7,200	164	.	12	12	6		15 3	11 0	26 3				
66	485	206	78 8	78 8	608	1 250	606	440	,,	1	..	5,100	119		8 4	8 4	8 4		0 8	21·0	21 8				
67	..		..	.				1,150	Wheat,	1		22,340			18 3	18 3	1·9	.	1 7	77·0	78 7				
69	540	572	75·4	85 8	1,544	854	401	510	,,	1	...	9 802	160		10 7	8 9	4 1		0·4	21·0	21 4				
72	540	286	11·4	11 4	10·40	1 500	815	450	,,	1	..	4,514	227	..	0 7	0 7	0 7	.	0 8	11 0	11 8				

TABLE A.—*Observation and Experiment*—(Continued)

STATISTICAL.

Serial Number	Province	District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Percentage uncultivated: Waste	Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Double cropped area in acres	Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Dry	Kharif: Wet: Wells	Kharif: Wet: Canals	Kharif: Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi: Wet: Wells	Rabi: Wet: Canals	Rabi: Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Dry bricks	Kacha	Total	Lifts: Leather bucket	Earthen pots	Total	Usual labor for lifting buckets	Average area per lift, in acres: Kharif	Rabi	Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
74		FARRUKHABAD.	Chibráman,	Deobarmpur,	1879-80	345 7	13 4	19·6	67 0	40 32	273·3	40·8	59 2	1 8	.	..	42 0	44·4	39 0			16 6	55 6		..	57	57	65	..	65	.	0 07	1 64	1 71	
75			"	"	80-81	345·7	13 4	19 6	67 0	47 21	278·6	47 5	52·5	1 8			44 4	40 2	35 4	10 3		8·1	59·8	.	..	57	57	65	.	65	..	0 07	1 52	1 59	
86			Amratpur,	Rajalpur,	79 80	952 2	17 3	6 5	70 2	.	704 9	2 1	99 0			..	0·9	0 9	2 1	.	.	97 0	99 1	1	2	10	19		21	21	Men		0·7	0·7	
87			"	"	80-81	952 2	19 3	6 8	73·0	198 3	881 5	6 5	93·5	0 7	.		55 0	56·8	5 8			37 0	43 7	1	- 2	68	71		74	74	"	0 08	0 7	0·7	
89			Farrukhabad,	Khaimpur,	79 80	222	11 44	18 45	70 11	127 5	283 13	56·53	43·47	2 09	..	.	40 92	13 01	53·87		0 57	2 05	56 99	.	2	61	09	63		68	Bullock	0 09	2 41	2 50	
			"	"	80-81	222	11 55	14·83	74 12	152 94	317 48	77 90	22 10	26 55	..		21 25	47 80	61 35	..		0 85	52 20	..	5	61	66	66	..	66	"	1 25	2 47	3·72	
			"	"																															
92			Tálgrám,	Tajpur,	79 80	129 14	14 5	46 5	39·0	45 83	96 17	78 9	21 1	2·4	..		10 0	12 4	76 5	..	.	11 1	87 5	..	12	33	45	33	.	33	"	0 08	2 33	2 41	
					80 81	129 14	14·5	46 6	38 9	51 23	101 46	88·0	11 4	33 5	..	..	10 0	44 1	55 1		.	0·8	55 0	..	12	33	45	33	.	33	"	1 00	1 68	2 68	
96			Bhongaon,	Bewar,	79 80	2370 9	10·35	26 11	63 54	70 4	15 77	9 01	80 09	67	.		48 46	49 13	8·88		36	41·65	50·87	4 p 1 2 p-4	.. ..	2 p-2 1 p 112	119	128	..	128	"	0·08	1·09	1 17	
98		MAINPURI	"	"	80-81	2370 9	10·35	16·85	72·80	..	17 26	40 35	59·65	13	77	18	49·89	44·97	8 53	27 76	2 98	15 76	55 03	4 p 1 2 p 4	. ..	1 p-89	94	101		101	"	0·02	1 46	1 47	First year of Canal, note effect.
100			Mainpuri,	Mainpuri,	79-80	2662 3	23 56	24 83	51 61	20 4	15 78	42 50	57 50	1 68	0·84	0 08	49 02	51 62	22 48	2 76	14·66	8 48	48 38	123	..	19	142	125		125	"	0 21	2 84	3 05	All these wells have splendid springs.
101			"	Bonamal,																															
102			"	"	80-81	2662 3	23·06	26 22	50·72	240 4	1590 8	53 07	46 93	11 86	2 14	0 52	42 24	56 76	21 75	3·74	13 06	4 69	48 24	125	..	10	136	128	.	128	"	1 47	2 70	4·17	
110			"	Jagrapur,	79 80	251·74	5 74	3 40	90 86	2 25	231	26 56	73·44	1 38	..	..	56 33	57 76	25 18	..	.	17 06	42 24	2	..	1	3	9	..	9	..	0 35	6 62	6·97	All these wells have splendid springs.
			"	"	80 81	251 74	7·0	0 02	86 98	12 4	231 34	28 6	71 4	4 6	.	..	62 8	67 4	24 0	..	..	8 6	32 6	3	..	..	3	10	.	10	..	1·06	5 55	6·61	

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE.

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well	Class	Cost: Construction	Cost: Fittings	Cost: Total	Cost: Renewal	Cost: Lifts	Cost: Yearly repairs	Cost: Total	Supply	Quality	Substratum	Cultivators on well: Number	Cultivators on well: Caste	Labor and cost per day in annas: Men, home	Do. hired	Rate, per day	Cattle	Cost for men	Do for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
74	11	1	82	160	Kacha lined,	3 75	8/	6 75	..	7/	1/	8/-	.	..	..	1	Kachi,	2	1	..	2	2 5	3	-/5/6
78	11	1	82	165	" "	3·75	8/	6·75	..	7/	1/	8/			..	3	"	2	1	.	2	2 5	8	/5/6
80		1	82	81	" "	5/	3/	8/		7/	1/	8/	..	..	.	1	"	3		..	2	2	3	/5/6
84	11	1	82	177	" "	3 75	3/	6 75	..	7/	1/	8/-	..	..	..	1	"	3	.	..	2	2	3	/5/
86 87 88	12 18	4 4	82 82	.. ..	" " " " Kacha unlined,	1 5 1 5 3/	1/- 1/ 3/	2 5 2 5 6/	1/ 1/	5 5 10/	. .. 1/	1 5 1 5 11/	. Spring,	.. Sweet,	Sand, " Clay,	1 1 1	" " "	1 2 1	 1 1	. 1 0 1 5	. 2	1 1 34	. .. 3	/1/ -/1/- -/6/6
90	13	4	82	23	" "	3/	3/	6/	.	9/	1/	10/	"	"	"	1	"	1	1 1	2 0 1.0	 2	3	3	/6/-
92	15	4	82	144/1	Kacha lined,	5/	3/	8/	1 5	8/	1/	10 5	"	"	"	1	"	3	.	.	2	2	3	/5/
94	15	4	82	185	" "	5/	3/	8/	1 5	8/	1/	10 5	"	"	"	1	Lodha,	1	2	2	2	4	8	-/7/
96	10	1	82	1,124	Masonry,	250/	6/	256/	.	5/	1/	11/	Percolation,	"	Sand,		"	1	3 1	75 1 6	4	3 0 1 5	0	/10/6
99 100	18 15	1 1	82 82	281 2,067	" "	250/ 400/	3/ 12/	253/- 412/	.	5/ 6/	1/ 1/	0/ 25/	Spring, "	" "	Clay, "	1 6 1 1 1	Brahmin, Lodha, Ahir, Chamar, Kachi,	3 7	 1	. 1 5	2 8	2 7 5	3 12	/5/- 1/3/6
106	15	1	82	2,090	"	400/	12/-	412/		5/	1/	21/	"	"	"	4 1 1	Lodha, Kachi, Ahir,	7		..	8	0	12	1/2/
110	16	1	82	81	"	250/	18/	268/	.	4/	1/	17/-	"	"	"	5 5 2	Brahmin, Chamar, Lodha,	. 7		.. ..	. 10	6	24	1/14/

EXPERIMENTAL.

Serial Number	Run: Class	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil	Command, Kharif 1881 82: Crop	Waterings required	Area.	Total area reduced to one watering	No of days to area.	Command, Rabi 1881 82: Crop	Waterings required	Area.	Total area reduced to one watering	No of days to area.	Area Irrigated to Date, Kharif 1881 82: Crop	Waterings given.	Area	Working days to date.	Duty: Per lift.	Duty: Per pair	Area Irrigated to Date, Rabi 1881 82: Crop	Waterings given.	Area	Working days to date.	Duty: Per lift.	Duty: Per pair
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
74	Lagor,	1	1	3 7125	34	36	35	Dumat,						Barley,	2	1 26	12 18	92							Barley,	2	1 26	16 0	0 157	0 157
														Gujal,	3	0 86									Gujal,	2	0 86	10·0	0·170	0 170
														Wheat,	4	0 66									Wheat,	2	0 66	8 0	0·160	0 160
														Opium,	12	0 37									Opium,	3	0 37	6·0	0 185	0·185
78	„	1	1	3 375	32	34	33	„						Gujai,	3	1 60	9 10	66							Gujai,	1 7	1 60	15·0	0·180	0 180
														Wheat,	4	1 09									Wheat,	1 5	1·09	13·0	0·126	0·126
80	„	1	1	..	30	35	32 5	„						Barley,	2	0 943	12 23	67							Barley,	1	0 943	8·0	0·118	0 118
														Gujal,	3	0 571									Gujai,	1	0 571	5·0	0 114	0 114
														Wheat,	4	1 257									Wheat,	2	1 257	14 0	0 79	0 179
														Opium,	12	0 300									Opium,	2	0 300	3 0	0·200	0 200
84	„		1	..	35		..	„						Wheat,	4	0 90	7 2	40							Wheat,	2	0 9	1·0	0·180	0 180
														Opium,	12	0 30									Opium,	2	0·3	3	0·200	0 200
86	Dhenkli,	..	1	0·4	15	15	15	Matyar,						Garden,	12	0 6	7 2	88							Garden,	„	0·6	„	0·080	..
87	„		1	0·4	16	16	16							Garden,	12	0·6	7 2	83							Garden,	„	0 6	„	0·086	
88	Lagor,	1	1	5·74	56	56	56	Dumat,	Indian corn,	2	1 5	3·46	18	Potatoes,	12	1 73	20 76	10 9	Indian corn,	2	1 5	9	0 38	0·38	Potatoes,	12	1 73	06	0·28	0 28
									Jowar,	2	0 28			Tobacco,	12	1 73	20·76	10 9	Jowar,	2	0 28	2	0·28	0·28	Tobacco,	„	1 73	„	0 20	0·20
90	„	1	1	4 80	57	59	58	„	Indian corn,	2	1 63	3 26		Potatoes,	10	1 63	16 30	57	Indian corn,	2	1 63	10	0 32	0·32	Potatoes,	10	1 63	50	0 32	
														Tobacco,	10	1 63	16 30	57							Tobacco,	„	1 63	„	0 28	
92	„	1	1	3·83	35	37	36	„	Jowar,	4	1 29	5 16	26	Potatoes,	10	1 29	12 90	66	Jowar,	4	1 29	20	0 20	0 26	Potatoes,	10	1 29	50	0 26	0 26
														Tobacco,	10	1 29	12 90	66							Tobacco,	„	1 29	„	0 25	0 25
94	„	1	1	4 6	34	37	35 5	„	Indian corn,	0	1 17			Potatoes,	10	1 17	11 70	58	Indian corn,	0	1 17				Potatoes,	10	1 17	10	0 19	0·19
														Tobacco,	10	1 17	11 70	58							Tobacco,	„	1 17	„	0·25	0·25
96	,	1	2	2 8125	14	24	19	Sandy,	„					Barley,	2	1 28	12 92	56·7	„						Barley,	1	1 28	81	0·105	0 105
														Gujai,	2	3 83									Gujai,	1	3·83			
														Wheat,	3	1·40									Wheat,	1	1 40			
99	„	1	1	·	15	·		Dumat,	„					Wheat,	3	1 20	3·60	21 6	„						Wheat,	1	1 20	6	0 20	0·20
100	„	1	4	3 1725	16	27	21 5	„	„					Gujai,	3	5 65	44·27	12 4	„						Gujai	1 8	5 65	2 5	0·101	0 101
														Barley & Gram,	2	3·86									Barley & Gram,	1 3	3 86	9 4	0 138	0 138
														Wheat „	3	3·20									Wheat „	1 6	3 20	13·1	0·100	0 100
														Garden,	10	0 40									Garden,	7	0·40	3·5	0 200	0·200
														Opium,	10	0·40									Opium,	3	0 40	2 1	0 148	0 148
														Tobacco,	10	0 20									Tobacco,	4	0·20	1 2	0 166	0 166
106	„	1	4	2 925	13	17	15	„	Sugarcane,					Barley,	2	2 97	40 93	58	Sugarcane,						Barley,	1·3	2 97	8 25	0 117	0 117
														Gujai,	3	2 77									Gujai,	1 54	2 77	8 5	0·126	0·126
														Wheat,	3	2 46									Wheat,	1 84	2 46	11	0 103	0 103
														Garden,	10	1 94									Garden,	7	1 94	26 25	0 183	0 183
110	„	2	4	2 54	18	23	20 5	„	„					Barley,	2	4 9	50 7	95							Barley,	2 47	4 9	23	0 131	0 065
														Wheat,	3	9 9									Wheat,	3	9 9	51	0 145	0 072
														Gujai,	3	2 1									Gujai,	2 4	2 1	8 5	0·149	0 074

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL — WORK: Duration of work minutes	No of lifts	Cubic feet lifted: Per pair of cattle per hour	Per lift, per hour	Total per well	H P: Per bullock	Total per well	Length of watercourse	Area Irrigated: Crop	Waterings	Interval	Area in square feet	Depth: On area	Of damp	Days to an Acre: Per pair of cattle	Per lift	Per well	Duty per pair	COST: Annual: Interest at 5 p. c.	Repairs, &c.	Total	Per Acre: Per acre Irrigated	Lifting	Total	Remarks
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
74	420	342	181	181	1,270	1 580	608	100	Wheat, .	3	.	5,731	2215	.	7 0	7 0	7 0		0·3	8 0	8·8				
78	518	823	128	128	1,080	1 125	574	560	" .	2		6,027	1007	..	7 2	7 2	7 2		0·8	8 0	8 8				
80		..	..	..		.	..	..	"	2	.	7,822		..	5 0	5 6	5 0	..	0 4	8 0	8 4				
84	.	..	.		.	.		..	" .	2		7,841	..	.	5 5	5 5	5 5	.	0 3	6 0	8·3				
86	823	8 50	..	94 8	848	447	148	100	Garden,	≈	.	3,483	10	0 6		12 3	12 3	.	0 1	1·5	1 6				
87	444	18 11	..	70 8	524	524	233	223	"	≈		3,788	14	0 7		11 5	11 5	..	0 1	1 5	1 0				
88	575	189	120	120	1,142	1 728	984	408	Tobacco,	≈	5 days,	8,280	18	73	5 27	5·27	5 27	..	0 3	11 0	11 3				
90	540	851	184	184	1,684	2 860	1,572	860	" .	≈		12,509	13	75	3 5	3·5	3·5	.	0 3	10 0	10.3				
92	568	385	187	187	1,280	1 825	740	250	"	≈	.	8,448	18	66	5 1	5 1	5 1		0·4	10 5	10·9				
94	525	380	170	170	1,540	1 685	885	460	" ..	≈		8,464	18	·75	5·0	5 0	5 0	..	0 4	10 5	10 9				
96	620	525	72	72	1,475	411	255	600	Gujal, .	1	..	9,775	145	50	8·9	8 9	4 4		12 8	11 0	23 8				
98		.	.		.	..	.		Wheat, .	1		7,600		.	6 0	6 0	6 0		12 0	6 0	18·6				
102	480	1 172	110	110	3,718	827	388	1,120	Wheat & Gram	1	..	15,302	24	75	11 2	11 2	2 8	.	20.6	25 0	45 6				
106	525	1,408	123	123	4,294	546	287	1,000	{ Barley, { Wheat, .	2 2	20 days, 20 days,	33,107	13	75	5 3	5 3	1 8	..	20 0	21·0	41 6				
110	640	2,210	66	132	5,629	400	250	910	Wheat, .	2	30 days,	23,040	0 24	0 55	1 5	7 3	1 88	.	16.1	17·0	33 1				

TABLE A.—*Observation and Experiment*—(Continued)

STATISTICAL.

Serial Number	Province	District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Percentage uncultivated: Waste	Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Cultivated Area: Double cropped area in acres	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Dry	Kharif Wet: Wells	Kharif Wet: Canals	Kharif Wet: Other sources	Kharif: Dry	Kharif: Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
113			Mainpuri,	Hasanpur,	1870 80	168 37	19 2	7 2	51 6	7 05	67 25	45 2	51 8	5 6	.	.	31 0	36·6
116			"	"	80-81	168 37	36 1	6·1	54 5	4 63	66 37	58 6	41 4	9 8		.	38·0	17 8
117			"	Sansarpur,	76 80	1142 1	30 57	16 08	59 30	54 4	733 50	41 5	58 5	6 4	.	.	47 9	53 6
119			"	"	86 81	1112 4	36 51	11 73	57 76	64 66	723 66	54 5	45 5	15 4	.	.	36 16	54 5
131	P	MAINPURI	Ghiror,	Ghiror,	79 80	6106 8	38 43	4 93	56 64	292 9	1368 8	57 82	42 18	7 95	5 26	0 16	26 84	43 21
			"	"	80-81	1906 8	41 67	5 87	52 46	274 97	1272 17	72 16	27 90	16 8	17 76	1 04	22 62	59 92
130			Shikohabad, 1st,	Mahirabad,	76 80	427 51	14 60	17 05	67 15	96 5	382 16	23 35	76 65	2 88			55·30	58 18
138			"	"	80 81	423·51	15·11	0·24	78 62	29 0	361·94	35 79	64 21	7 22		0 36	57 66	64 64
141			"	Shikohabad,	76 80	781 29	36 6	7 3	62 8	150·43	612 43	33 6	66 4	1 2	.		60 2	64 4
143			"	"	90 81	781 29	26 8	0 0	61 3	108 14	592·23	52 5	47 5	14 05	..	0 65	43 4	58·1
147			" 2nd	Mustpur,	76 80	398 63	12 9	28 8	58 3	0·8	233 1	42 5	57 5	0·4		.	18 9	49 3
			"	"	80 81	398 63	13·5	20 5	57 0	32 1	256 33	50 9	49·1	1 0	..	.	46·5	47 5

Serial Number	Rabi Wet: Wells	Rabi Wet: Canals	Rabi Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Dry bricks	Kacha	Total	Lifts: Leather bucket	Earthen pots	Total	Usual labor for lifting buckets	Average area per lift, in acres: Kharif	Rabi	Total	Remarks
1	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
113	30 6	.		28 8	63·4	1 p-2	..	1 p 1	3	6	.	9	..	0 60	4 28	4 88	All these Wells have splendid springs
116	48 8	.	.	3 4	52 2	4 p 3	..	1 p 1	3	9		9	..	1 65	5 22	6·27	" "
117	85 1	.	..	11 3	46·4	25	..	7	32	51	7	58	.	0 81	4 44	5 25	" "
119	39·1	.	.	6 4	45 5	27	..	15	42	45	15	60	..	1 85	4 72	6 57	" "
131	15 91	26 97	1 57	12 34	56 79	2 p 4 1 p 16	.	61	81	85	.	85	.	1 28	2 50	3·84	Village close to Ganges Canal Note Kucha wells.
	26 46	21 76	0 34	5 28	47 78	2 p-4 1 p 16	..	66	86	66		90	.	1 52	2 88	4 40	
130	26 04	..	0 43	21 35	41 82	..	.	25	25	27	.	27	.	0 40	2·83	3·28	
138	17 26	10·65		7 15	35 36	..	..	28	28	28		28	.	0·62	2 22	3·14	First Year Canal. Note effect
141	26 4		.	6 2	35 6	18	.	58	76	99	.	62		0·36	2 64	2 34	
143	33·0	0·8	4 0	4 1	41 9	16	..	67	86	93		93		0·05	2 15	3 10	
147	42 1		..	8·6	56 7	2 p 1 1 p 1	..	25	37	28		28	..	0 03	2 45	2 48	
	7 2	42 7	.	2·6	59 5	2 p-1 1 p-1	..	26	28	26		29	..	0 10	0 45	0·55	

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE.

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well.	Class	Cost: Construction.	Cost: Fittings.	Cost: Total.	Cost: Renewal	Cost: Lifts.	Cost: Yearly repairs.	Cost: Total.	Supply	Quality	Substratum	Cultivators on well: Number	Cultivators on well: Caste	Labor and cost per day in annas: Men, home.	Do. hired.	Rate, per day	Cattle.	Cost for men	Do. for cattle.	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
118	10	1	82	109	Masonry,	250/	10/	260/	.	5/	1/	16/	Spring,	Sweet,	Clay,	4 3 1 1	Brahmin, Chamar, Kachi, Herdsman,	0	1	1·5	0	6·5	9	-/15/6
117	17	1	82	510	"	250/	12/	262/	..	6/	1/	25/	"	"	"	12 1	Brahmin, Ahir,	5	4	1·5	9	10	13·5	1/7/6
120	18	1	82	511	"	150/	6/	156/	..	5/	3/	13/	"	"	"	7	Brahmin,	3	2	1·5	4	5	6	-/11/
123	18	1	82	701	"	200/	6/	206/	..	5/	3/	13/	"	"	"	12	Brahmin,	4	1	1·5	6	4·5	9	/13/6
128	18	1	82	1,010	"	250/	12/	262/	.	5/	1/	21/	"	"	"	6 1 1	Brahmin, Chamar, Kachi,	2	5	1·5	6	8·5	9	1/1/6
131	19	1	82	2,069	"	100/	3/	103/	..	7/	1/	8/	Percolation,	"	Sand,	1 3	Lodha, Kachi,	3		..	2	2	3	/5/-
133	19	1	82	2,070	"	100/	3/	103/		6/	1/	7/	..		..	2 1 1	Chamar, Kachi, Lodha,	2	1	1·5	2	2·5	3	/5/6
136	21	1	82	133	Kucha lined,	4/	2/	6/	4/	7/	.	11/	"	"	Clay,	1	Lodha,	2	1	1·5	2	2·5	3	/5/6
138	21	1	82	125	" "	4/	2/	6/	4/	7/	.	11/	"	"	"	1	Lodha,	1	2	1·5	2	4	3	-/7/
140	21	1	82	127	" "	4/	2/	6/	4/	7/	..	11/	"	"	"	1	Lodha,	2	1	1·5	2	2·5	3	/5/6
141	22	1	82	514	" "	7/	2/	9/	4/	7/	.	11/	Spring,	"	"	1 1	Lodha, Ahir,	1	2	1·5	2	3	3	-/6/-
143	22	1	82	683	Masonry,	150/	6/	156/	..	7/	1/	15/	"	"	"	1	Lodha,	1	2	1·5	4	3	6	/9/
147	23	1	82	201	Kucha lined,	7/	3/	10/	3/	6/	..	9/	Percolation,	"	Sand,	1	Ahir,	3	.	..	2	2	3	-/5/

TABLE A.—*Observation and Experiment*—(Continued)

	Experimental.																													
									Command										Area Irrigated to date.											
	Run		*Lift*		*Depth to Wells*				*Kharif* 1881 82					*Rabi* 1881-82					*Kharif* 1881 82				*Duty*		*Rabi* 1881 82				*Duty*	
Serial Number	Class	Pairs of cattle to each lift.	Number	Content in cubic feet.	Morning	Evening	Mean.	Soil.	Crop.	Waterings required.	Area.	Total area reduced to one watering	No of days to area.	Crop	Waterings required	Area.	Total area reduced to one watering	No. of days to area.	Crop	Waterings given.	Area.	Working days to date.	Per lift.	Per pair	Crop	Waterings given	Area	Working days to date.	Per lift.	Per pair
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
113	Lagor,	1	3	2 7	16 6	18	17 3	Dumat,	Sugarcane,	..	.	.	..	Gujai,	8	13·0	52 12	151	..	.	..	..	.	..	Gujai,	2	13·0	55	0 151	0 151
														Wheat,	3	8 4									Wheat,	3	8 14	18	0 174	0 174
														Garden,	10	0 37									Garden,	5	0·37	5	0 128	0·128
117	„	1 125	4	3·15	18	20	19	„	„	..	2 8	..	.	Barley,	2	3·23	50·08	100	..	2	2·8	..	..	..	Barley,	2	8 23	16 5	0 100	0·088
														Gujai,	8	3 11									Gujai,	2	3 11	16	0·100	0·038
														Wheat,	8	11 43									Wheat,	2	11 43	56 5	0 100	0 088
120	„	1	2	2 95	17	20 5	18·75	„	„	4	3 17	12·68	88	Barley,	2	2 51	15 46	46	..	1 5	2 8	12	0·175	0·175	Barley,	1 7	2 51	14·0	0·152	0·152
														Gujai,	8	1 23									Gujai,	1	1 23	5	0 123	0 123
														Wheat,	8	2 25									Wheat,	1 8	2 25	14 5	0 140	0·140
123	„	1 5	2	3 015	16	26	21	„	„	4	1·8	7 2		Gujai,	3	1 97	80 30	86	..	2	1 8	14	0·130	0·09	Gujai,	2	1 97	18 0	0 150	0 100
														Gram,	2	0 40									Gram,	2	0 40	2 0	0 200	0·138
														Carrots,	10	0 77									Carrots,	5 7	0·77	13 0	0 160	0 112
														Wheat,	3	4 70									Wheat,	1 7	4·70	28 0	0 142	0 095
														Barley,	2	5·40									Barley,	1 5	5 40	24 0	0 170	0·113
128	„ (44 ft.)	1	16-1-82 3	3·094	16	18	17	„	„		..	..	.	Barley,	2	2 77	45 74	102	..	..	..	..			Barley,	2	2 77	13 0	0 142	0·142
														Wheat,	8	10 29									Wheat,	3	10·39	72·0	0·142	0·142
														Gujai,	3	8·11									Gujai,	3	8 11	15 0	0 207	0 207
131	„	1	1	4 05	10·4	17	13 7	Matyar,	„	..	.	.	.	Tobacco,	12	0 91	24·3	181	.	..	..	..	..		Tobacco,	10	0 91	30·0	0 303	0·308
														Wheat,	8	4 46									Wheat,	2	4·46	88·0	0 234	0 284
133	„	1	1	3·19	9	13	10 5	Dumat,	„		..	..		Barley,	2	1 50	13 18	76	..	..	..	..	..		Barley,	1	1·50	9	0 166	0·166
														Wheat,	3	1 86									Wheat,	2	1 86	16	0 232	0·232
														Opium,	10	0 46									Opium,	8	0·46	8	0·460	0 460
136	„	1	1	4 05	13	18	15	Sandy,	„				.	Wheat,	3	2 98	11 18	80		.	..	.	.		Wheat,	387	2 98	8 5	0 124	0 124
														Barley,	2	1 12									Barley,		1 12	.		
139	„	1	1	4 106	13	21	17	Dumat, Sandy,	„		.	..	.	Wheat,	8	5 31	17·43	68	..	..	.				Wheat,	1 53	5 31	55	0 147	0 147
														Garden,	10	0 15									Garden,	5	0 15	2 5	0 300	0·300
140	„	1	1	4 16	13	23	18	Dumat,	„	..	.	..		Wheat,	8	4 4	13·2	42	.		.	..	..		Wheat,	1 2	4 4	88	0 165	0 165
141		1	1	4·05	14 5	19	16·75	„	„		..	.		Wheat,	3	4 1	12 8	78	..		..	..	.	..	Wheat,	1 11	4 1	30·5	0·150	0·150
143	„	1	2	4 725	17	24 5	20·75	„	„		.	..	..	Barley,	2	1 9	33	125	..	..	..		.		Barley,	1	1 9	11	0·090	0·090
														Wheat,	3	3 17									Wheat,	37	8 17	6	0 100	0 100
														Potatoes,	10	1 3									Potatoes,	9	1 8	54	0 108	0·108
														Carrots,	10	0 7									Carrots,	9	0 7	27	0 117	0·117
147	„	1	1	3·4875	21 5	29	25 25	„	Failed,	.	..		..	Barley,	2	0·37	10·52	84	..	..	..	..	.	.	Barley,	1	0 37	3	0·123	0 128
														Gujai,	8	1 74									Gujai,	1	1 74	18	0 096	0·096
														Wheat,	4	1 14									Wheat,	1	1 14	12	0·095	0·095

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL — WORK: Duration of work minutes	No of lifts.	Cubic feet lifted: Per pair of cattle per hour	Per lift, per hour	Total per well.	H P: Per bullock.	Total per well.	Length of watercourse.	Area Irrigated: Crop.	Watering	Interval.	Area in square feet.	Depth: On area.	Of damp	Days to an Acre: Per pair of cattle.	Per lift.	Per well.	Duty per pair	COST — Annual: Interest at 5 p c.	Repairs, &c.	Total.	Per Acre: Per acre Irrigated	Lifting	Total	Remarks
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
113	540	1,303	129	129	8,518	·605	830	1,280	Gujal,	2	45 days,	14,904	236	66	8 8	8·8	2 9		13 0	16 0	29·0				
117	600	2,111	147	166	6,650	771	463	1,710	Barley,	2	30 days,	22,000	87	75	9·0	8 0	2 0		13 1	25·0	38·1		..		
120	595	1,112	166	106	8,280	892	531	370	Barley,	2	45 days,	14,330	228	80	6 0	6 0	3·0	.	7 8	13·0	20·8	.		.	
128	680	1,195	114	171	3,603	787	496	{870 870 550	Carrots, Wheat,	5 2 2	x 30 days,	3,332 5 130 6,900}	274	75	6·5	4 3	2 18		10 3	13 0	23·0		.		
128	520	1,095	180	130	8,388	612	318	1,050	Wheat,	3	45 days,	19,434	174	75	6 72	6 72	2 24		13 1	21 0	34 1		..	..	
131	550	620	274	274	2,511	1 200	600	370	Wheat,	2	90 days,	8,027	31	1·0	5·4	5·4	5 4		5 1	8 0	13·1			.	
133	530	458	184	184	1,598	556	295	680	Wheat,	2	30 days,	7,500	226	75	5 8	5 8	5 8		5 1	7 0	12 1	.		.	
136	876	201	187	187	1,178	873	828	450	Wheat,	1		4,890	24	30	8 0	8 0	8·0		0·3	11 0	11 3		.		
138	522	540	255	255	2,217	1 880	720	370	Wheat,	2	37 days,	11,322	195	66	3 9	3 9	3 9		0·3	11·0	11·3				
140	530	405	222	222	1,034	1 302	690	340	Wheat,	2	45 days,	13,450	144	5	3 2	3·2	3 2		0·3	11·0	11 3		..		
141	308	207	182	182	1,203	0 900	355	240	Wheat,	2	30 days,	7,240	163	5	6·0	6 0	6 0	.	0 5	11 0	11 5	..		.	
143	360	563	222	222	2,660	1 888	500	560	{Wheat, Barley,}	1		11,400	233	3	7 0	7 0	3·8	..	7 8	15·0	22·8		.	.	
147	440	308	140	140	1,074	1 107	487	180	Wheat,	2	30 days,	5,332	194	3	3	3	8		0 5	9·0	9 5	..	..		

TABLE A —*Observation and Experiment*—(Continued)

STATISTICAL.

Serial Number	Province	District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Percentage uncultivated: Waste	Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Cultivated Area: Double cropped area in acres	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Dry	Kharif Wet: Wells	Kharif Wet: Canals	Kharif Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi Wet: Wells	Rabi Wet: Canals	Rabi Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Dry bricks	Kacha	Total	Lifts: Leather bucket	Earthen pots	Total	Usual labor for lifting buckets	Average area per lift, in acres: Kharif	Rabi	Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	N W P	MAINPURI	Shikohabad,	Mustpur, (contd)		...	...			...		.		..		...		.		...		...	..	...	.	...	.	..	..	.	..	...	...		
156			,,	Fkka, (Chamnagar,)	1879 80	8460·3	39 6	9·8	50·60	9·35	5214 1	49 43	50·57	5·59	0·20	0·04	46·05	51 88	42·90	0·66	0·04	4·52	48 12	8 p-1 6 p 10 4 p 79	2 p-85	2 p-17 1 p-45	237	638		638	Bullock,	0·46	3 54	4·00	Splendid springs W S raised 5 to 6′ by Canal.
			,,	,,	80-81	8460·3	39·4	11·4	49·20	94·98	5103 8	74·29	25 71	26·65	0·85	3·12	22 20	52 32	42·67	1 46	0·04	3·51	47 68	8 p 1 6 p-10 4 p-79	2 p-87	2 p 17 1 p-47	241	639	. .	639	,,	2 18	3·40	5 53	
166			,,	Gopalpur,	79-80	1188·5	58 80	5 37	35 83	24·86	450 72	17 25	82·75	0·70		0 34	48 80	44·84	7·41	8·70	0 10	38·95	55·16	4 p-1 2 p-9 1 p-2		2 p-4									
			,,		80 81	1188 5	59 50	7 14	33 36	38·71	435·08	47 67	52·33	8 20	0·98	0·72	30·70	40 55	28 13	8·58	1 11	21·63	59 40	4 p-1 2 p-9 1 p-2		1 p 1 2 p-4 1 p-3	17 19	33 35	. ...	33 35	,, ,,	0·10 1 01	1 01 2·44	1 11 3·45	W S. raised 6′ by Canals
173			,,	Ooresar, (Gurra Muzra,)	79 80 80-81			..				...	.		..	...				...	...	.	...	...	...	.					...		...		
178		ETAH	Etah Sakhet,	Chachona,	79 80	272 4	14 2	15 8	70·0		190·9	42 74	57 26	...	22 27	0·07	50 20	72 54	0 89	19 33	0 18	7·06	27·46		2	.	2	3		3	,,		0·6	0·06	17 Wells not used on account of Canal
					80 81	272 4	14·2	16·8	69 0		188 4	47 59	52 41	0 57	18·42	..	51 68	70·67	0·72	27·88		0·73	29 88		2	.	2	3		3	,,	86	0·45	1·81	
180			,,	Mubarikpur,	79-80	380 0	38 3	13·3	48 5		184·0	27 1	72·4	0·3	3 6		56 5	60 4	20 2	3 0		16 4	30·6		4 p-2	2 p 5	15	30	..	30	,,	·02	1 24	1 26	
					80-81	380·0	38 2	13·6	48 2		182 8	23 11	76 89	2·38	2 33		65 94	70·65	13·45	4 95		10·95	29 25		2 p-4 1 p-1	1 p-3	15	30		30	,,	14	0·81	0·95	

TABLE A —*Observation and Experiment*—(Continued)

DESCRIPTIVE.

Serial Number	*Date* Day	Month.	Year	Number of Well	*Class*	*Cost.* Construction.	Fittings.	Total.	Renewal.	Lifts.	Yearly repairs.	Total.	*Supply*	*Quality*	*Substratum*	*Cultivators on well* Number	Caste	*Labor and cost per day in annas* Men, home.	Do hired.	Rate, per day	Cattle	Cost for men	Do for cattle	Total cost, per day
37	38	39	40	41	42	48	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
150	28	1	82	292	Masonry, .	200/	8/	208/-	.	8/	1/-	9/	Spring,	Sweet, .	Clay,	1	Ahir, ..	2	2	1 5	6	4	9	/18/-
153	23	1	82	100	"	300/	6/-	306/-		7/	1/-	15/-	"	" .	" 60',	8	" ..	4	1	1.5	9	4 5	13 5	1/2/-
155	24	1	82	4,248	Dry brick,	200/	10/	210/-	...	6/	1/-	25/	"	"	" 80,	1	" ...	3	4	1 5	8	8	12	1/4/-
160	24	1	82	4,247	" "	200/	15/-	215/		5/-	1/-	31/-	"	" ..	"	4 2 1 1	Kachi, Ahir, Brahmin, Chamar,	4	8	1 5	18	7 5	19 5	1/11/-
166 167	25 26	1 1	82 82	220	Kucha lined with wood below,	30/ 30/- 30/ 30/-	4/ 4/ 4/ 4/	186/		6/ 6/ 6/ 6/	1/ 1/ 2/ 2/	30/-	" . " " " ..	" " " "	Clay, 32,	11	Herdsmen,	2 6	3 3	1 5 1.5	4 14	5 5 9.5	6 21	-/11/6 1/14/6
170	25	1	82	341	Masonry,	200/	6/	206/-	..	6/	1/	13/	" .	"	"	2 5 1	" Ahir, Thakur,	2	2	1.5	4	4	6	-/10/-
173	26	1	82	105	Dry brick, .	150/-	12/	162/-	..	5/-	2/	22/-	Percolation,	"	" .	8	Herdsmen,	6	..	.	8	5	12	1/1/-
178	27	1	82	284	Masonry, "	150/ 200/	6/ 6/	362/-	..	5/	2/	17/	Spring, .	" ...	Clay, 45',	7	Ahir, ..	5	1	1 5	6	5 5	9	/14/6
180	27	1	82	29	"	100/-	6/-	106/-		5/-	1/	11/	"	"		1 1 7	Brahmin, Kachi, Ahir,	2	2	1.5	4	4	6	-/10/-
188	27	1	82	33	"	100/	6/	106/-	...	5/	1/	11/-	"	" ..	"	1 13 1	Kachi, Ahir, Carpenter,	2	1	1 5	4	2 5	6	-/8/6

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL. Run: Class	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean	Soil.	COMMAND. Kharif 1881 82: Crop	Waterings required.	Area.	Total area reduced to one watering	No. of days to area.	Rabi 1881 82: Crop	Waterings required	Area.	Total area reduced to one watering	No. of days to area.	AREA IRRIGATED TO DATE. Kharif 1881-82: Crop	Waterings given.	Area.	Working days to date.	Duty: Per lift.	Duty: Per pair	Rabi 1881-82: Crop	Waterings given.	Area	Working days to date.	Duty: Per lift.	Duty: Per pair.
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
150	Kill,	3	1	5·2875	31	28	24 5	Matyar,	Failed,			...		Barley,	2	5 77	29 25	126	Sugarcane,						Barley,	1	5 77	25	0 230	0·073
														Wheat,	3	4 57									Wheat,	2	4 57	36	0·254	0·085
														Carrots,	10	0·4									Carrots,	3	0·4	45	0 266	0 089
153	"	2 25	2	4·67	16 0	31	23·8	Dumat,	"					Wheat,	3	12 08	49 50	114	"						Wheat,	1 7	12 08	42	0 244	0·109
														Barley,	2	6·68									Barley,	1	6 68	15	0 221	0·100
155	Lagor,	1	4	3 375	10	17	18 5	"	"					Gram,	1	2·86	63 0	118	"				...		Gram,	1	2 86	6	0·219	0·219
														Barley,	3	1 18									Barley,	3	1 18	4	0 147	0·147
														Wheat,	4	8 14									Wheat,	2	8 14	42	0 097	0·097
														Gujai,	4	2 03									Gujai,	2	2·03	12	0·085	0·085
														Guchana,	3	5 3									Guchana,	2	5 80	25	0 106	0·106
160	"	1·017	6	2 78325	10	16	18 2	"	Sugarcane,	4	1 40	5 84		Gram,	1	2 5	96 57	135	"	4	1·46	8	0·121	0·119	Gram,	1	2 5	3	0 189	0·136
														Barley,	3	11 14									Barley,	1 3	11 14	27	0 124	0·121
														Wheat,	4	6·28									Wheat,	3	6 23	25	0 083	0·081
														Gujai,	4	1 68									Gujai,	2	1 68	55	0·102	0·100
														Guchana,	3	3 47									Guchana,	0 34	3 47	2	0 096	0·096
														Opium,	10	1 86									Opium,	4	1 86	12	0 124	0·121
166	"	1	2	3·2625	9	15	12	Mixed,	"					Barley,	3	3 66	120	180	"						Barley,	1 5	3 66	3	0 086	0 084
														Gujai,	4	3 50									Gujai,	1 5	3 5	7 5	0 081	0·080
167	"	1 17	6	3 2711	9	15	1[illegible]	"	"					Wheat,	4	2 03									Wheat,	1·7	20 3	5 6	0 077	0.075
														Carrots,	10	1 37									Carrots,	2	1 37	3	0.144	0·142
170	"	1	2	3 263	11	12 3	11 65	Dumat,	"					Barley,	3	3·30	89 8	207	"						Barley,	2	8 30	26	0 127	0·127
														Wheat,	4	6·00									Wheat,	2 5	6 00	69	0·109	0·109
														Carrots,	10	0 54									Carrots,	4	0 54	6	0 180	0·180
173	"	1	4	2 70	15	22	18 5	Matyar,	"					Gram,	1	0 17	88 8	160	"						Gram,	1	0·17	0 5	0·085	085
														Barley,	2	7 70									Barley,	1 5	7 70	25 5	0 113	113
														Gujai,	3	0·45									Gujai,	2	0 45	2 5	0 086	86
														Wheat,	3	2·68									Wheat,	2	2 63	12 0	0 109	109
														Garden,	10	1 40									Garden,	3	1·40	8·5	0 102	102
178	"	1	2	2 86	11 0	17 5	13·6	"	"	3	1 70	5 10	20	Barley,	3	2·00	16·8	67	"	3	1 70	15	113	118	Barley,	1 87	2 00	7	130	130
	"	1	1		11 6	14 6								Wheat,	4	2 70									Wheat,	2	2 70	14	178	178
180	"	1	2	2 475	11	11	12 5	"	"					Barley,	3	0 66	28	121	"						Barley,	1 6	0 66	7·5	070	070
														Wheat,	4	6 00									Wheat,	1 5	6·00	64	070	·070
														Opium,	10	0 20									Opium,	2	0 20	2	100	100
183	"	1	2	2 62	10 6	13 4	13	Dumat,	"					Barley,	2	1 80	80	192	"						Barley,	1 82	1 80	27	·060	·060
														Gujai,	3	1 20									Gujai,	2	1 26	18	070	·070
														Wheat,	4	2·30									Wheat,	2	2 30	37	062	062
														Opium,	8	1·00									Opium,	2	1·00	13	080	080
														Carrots,	10	0 54									Carrots,	3	0 54	125	070	070

TABLE A.—*Observation and Experiment*—(Continued).

Serial Number	EXPERIMENTAL. WORK. Duration of work minutes.	No. of lifts.	*Cubic feet lifted* Per pair of cattle per hour	Per lift, per hour.	Total per well.	*H P* Per bullock.	Total per well.	Length of watercourse.	*Area Irrigated* Crop.	Watering	Interval.	Area in square feet.	*Depth* On area.	Of damp	*Days to an Acre* Per pair of cattle.	Per lift.	Per well.	Duty per pair.	COST. *Annual* Interest at 5 p. c.	Repairs, &c.	Total.	*Per Acre* Per acre irrigated.	Lifting.	Total.	Remarks
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
150	480	347	77	230	1,835	550	204	970	Wheat, ..	2	60 days	10,055	182	5	12 9	4 3	4 3		10 1	0 0	10 1				
153	478	911	124	270	4,894	988	407	410	Wheat, ..	2	30 days	10,230	228	·70	10 0	4 5	2 20	..	15·3	15 0	30 3				
155	557	1,745	158	158	5,890	·700	388	1,700	Guchana,	2	45 days	24,850	241	55	7	7	1 8		10·5	25 0	35·5				
160	546	2,007	84 6	80	5,580	381	208	740 1,650	} Barley, .	{ 2 2	45 days 38 days	20,709 10,430	} ·180	55	8 6	8 4	1 4	.	10 7	31·0	41 7				
166	380	400	129	129	1,028	·480	186	600	Carrots,	2		11,100	145	60	7 8	7 8	} 1 5		6 8	30	36·8				
167	585	2,017	100	115	9,097	381	223	2,400	Wheat, .	2	40 days	18,010	37	1 0	10·8	14·4									
170	380	430	110	110	1,403	352	184	810	Barley, .	2	45 days	8,252	107	70	10 5	10 5	5·27	..	10·3	13·0	23 3				
173	118	1,413	92	92	3,816	·538	329	2,100	Barley, ..	2	50 days	9,802	38	80	17 6	17 0	4·4	.	8 1	22	30 1				
178	560	1,010	100	100	2,974	488	245	1,060	Wheat, ..	2	60 days	10,031	·27	55	12	12	4	...	13 1	17 0	30 1				
180	570	828	107	107	2,087	·392	223	950	Wheat, .	2	45 days	10,025	20	·60	8 7	8 7	4·84	..	5 3	11·0	16 3				
183	574	817	112	112	2,140	380	223	370	Wheat,	2	60 days	6,840	·31	1 0	12 7	12 7	6 4	..	5·3	11·0	16 3				

TABLE A —*Observation and Experiment*—(Continued)

STATISTICAL.

Serial Number	Province.	District.	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres.	Percentage uncultivated: Waste.	Percentage uncultivated: Culturable.	Cultivated Area: Percentage of actual area cultivated.	Cultivated Area: Double cropped area in acres.	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Dry	Kharif: Wet: Wells	Kharif: Wet: Canals.	Kharif: Wet: Other sources.	Kharif: Dry	Kharif: Total	Rabi: Wet: Wells	Rabi: Wet: Canals.	Rabi: Wet: Other sources.	Rabi: Dry	Rabi: Total.	Irrigation Wells: Lime masonry	Irrigation Wells: Dry bricks.	Irrigation Wells: Kacha.	Irrigation Wells: Total.	Lifts: Leather bucket.	Lifts: Earthen pots.	Lifts: Total.	Usual labor for lifting buckets.	Average area per lift, in acres: Kharif.	Average area per lift, in acres: Rabi	Average area per lift, in acres: Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
188		ETAH.	Etah,	Bazlpur,	1879-80	1224 2	33 82	14 78	51·40	..	629 4	93 2	6 8	26 2	.		1 70	27 9	67 0	.		5 1	72 1	4 p 31 1 p 5	.	1 p 2	38	131	.	131	Bullock,	1 26	3 22	4·18	
			"	"	80 81	1224 2	33 80	12·20	54·00		659·6	75 1	24 9	30 4			10 6	50·0	35 7	..	.	14 8	50·0	4 p-31 1 p 5	..	1 p 3	39	132	.	132	"	2 00	1 78	3 78	
195			Marehra,	Tekhpur Khas,	79 80	1203	0 62	13 60	76 78	291 6	1214·4	40·49	59 51	0·72	25 46		33 65	59 83	2 57	11 74		25 86	40·70	3 p-2 1 p 7		1 p 6	15	12	.	12	"	0 73	2 65	3 38	
			"	"	80-81	1202	0 60	13 55	76 85	313·6	1267 1	49 79	50 21	4 21	29 70	0·49	22 11	56 51	3 18	12 16	0 05	28 10	43·49	2 p 3 1 p 7	..	1 p 9	18	20		20	"	3 67	2·01	4·08	
200		ALIGARH.	Secunder Rao,	Secunder Rao,	79 80 80-81	.					.				.		.	..	.			..		..	..	.		.	.				..	..	
207	P		"	Gopi,	79 80	4141 7					.					.	.			.			.		.	.	.				..		.		
	"		"	"	80-81	4141 7	35·6	9 6	54 8	208 60	2476 86	69 86	30 14	22 08	6·98	1 90	26 60	57 56	22 07	15 67	26	3 54	42 44	4 p 5 3 p 5 3 p-11 1 p 7		. 2 p-6 1 p-30	64	106		106	"	5 16	.. 5 35	10 51	All wells worked Kili with 2 to 3 pairs of cattle to each lift.
217			"	Nanu,	79 80	1095 7	34 88	5 14	59 98	207 91	1380·0	56 2	43·8	7 6	8 7		20·7	37 0	16 1	23·8		23 1	63 0	3 p-4 1 p-5							.				As above.
			"	"	80 81	1095 7	34 56	4 59	60·85	220 31	1410·4	75 0	25 0	9 0	25 7		9 1	43 8	23 4	16 9		15 9	56 2	3 p-4 1 p 5	1 p 2	1 p 15	26	30		30	"	3 5	7·42	10 92	
																									1 p 2	1 p-14	25	29		20	"	4·38	11 37	15 75	
			Aligarh,	Dodepur,	79 80	314 23	29 7	2 4	67 0	34 66	218·10	66 5	33 5	17 2			22 3	39 4	49 3		.	11 3	60 6	4 p-4 2 p 2											
			"	"	80-81	314 23	30 1	1 2	68 7	40 5	256·1	65 5	34 5	14 0	..	..	30 0	44 0	51 5			4 5	56 0	1 p 2 4 p-4		1 p-3	11	25		25	"	1 71	4 9	6·61	Very good cattle in this village.
																								2 p 1 1 p-3	.	1 p 8	11	24		24	"	1 48	5 5	6 98	" "

TABLE A.—*Observation and Experiment*—(Continued).

DESCRIPTIVE

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well	Class	Cost: Construction	Cost: Fittings	Cost: Total	Cost: Renewal	Cost: Lifts	Cost: Yearly repairs	Cost: Total	Supply	Quality	Substratum	Cultivators on well: Number	Cultivators on well: Caste	Labor and cost per day in annas: Men, home	Do hired	Rate, per day	Cattle	Cost for men	Do for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
188	28	1	82	286	Masonry,	250/-	0/	250/	.	0/	1/	10/	Spring, .	Sweet,	Clay 30',	1 5 1 1	Writer, Lodhas, Thakur, Fruit seller,	6	1	1 5	4	0 5	12	1/2/6
192	28	1	82	305	" .	100/	0/	100/		5/	2/	12/	" .	"	" 30',	1 10	Thakur, Lodhas,	3			4	2	6	-/8/
196	29	1	82	485	Kacha lined, .	14/	8/	17/	2/	5/	1/	8/	" .	" .	" 36',	1	Thakur, .	3 ..			4	2	6	-/8/-
199	29	1	82	508	Masonry,	200/	3/	203/		8/	1/	9/-	" .	" .	" 30',	1 7 1	Pandit, Thakurs, Clerk,		3	1 5	2	4 5	8	/7/6
200	30	1	82	485	"	150/	3/	153/	.	8/	1/	9/	" .	" .	" 24',	1 1	Pathan, Dhobi, .		2 1	1 25 0 5	4	3	6	-/9/-
203	30	1	82	470	" .	100/	3/	103/		8/	4/	12/-	Percolation,	" ..	" 24', .	1	Ahir, .	2	1	1 25	4	2 21	6	/8/3
207	31	1	82	1,123	" .	200/	3/	203/	.	8/	2/	10/	Spring, .	"	" 30',	1 5	Thakur, Chamars,	1	2	1·5	6	3	9	/12/-
211	31	1	82	1,180	Dry brick, .	150/	0/	150/-	.	8/	1/	17/	"	" .	" 33',	2 1	Chamars, Thakur,	6		.	6	5	9	/14/
217	1	2	82	91	Masonry,	150/	0/	150/	.	10/	1/	21/	"	" .	" 42', ..	7	Musalmen,	3	4	2 0	12	10	18	1/12/-
221	1	2	82	102	" .	100/	3/	103/		10/	3/	13/	" .	" .	" 40',	1 4	Musalman, Kachis, Thakur,	2	1	1 5	2	2 5	8	/5/6
225	2	2	82	174	"	250/-	10/	260/		10/	1/	31/	" .	" .	" .	7	Chamars, ..	7			12	6	18	1/8/

TABLE A — *Observation and Experiment*—(Continued)

EXPERIMENTAL.

Serial Number	Run: Class.	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil	Command, Kharif 1881 82: Crop	Waterings required.	Area	Total area reduced to one watering	No. of days to area.	Command, Rabi 1881 82: Crop	Waterings required.	Area.	Total area reduced to one watering	No. of days to area.	Area Irrigated to Date, Kharif 1881 82: Crop	Waterings given.	Area.	Working days to date.	Duty: Per lift.	Duty: Per pair	Area Irrigated to Date, Rabi 1881 82: Crop	Waterings given	Area	Working days to date.	Duty: Per lift.	Duty: Per pair
62		63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
188	Lagor,	1	2	2 77	16·0	22 8	19 7	Dumat,	Sugarcane,					Barley,	3	1 32	34 5	45	Sugarcane,		..		..		Barley,	2	1 32	4	220	165
	Kill,	2	1	5·03										Wheat,	4	7 63									Wheat,	2 6	7 63	71	093	071
192	Lagor,	1	2	2 88	16 6	22 0	19 5	"	"					Barley,	3	4 0	2 6	201	"		..				Barley,	2	4 0	54	071	074
														Wheat,	4	1·3									Wheat,	3	1 3	24	081	081
														Carrots,	8	1 10									Carrots,	1	1 10	25	090	090
195	Kill,	2	1	.	.		18	"	"					Wheat,	4	1 6	0·4	32	"						Wheat,	3	1 6	24	200	100
199	" 2 Lift,	1	1	5 5125	18	21 5	19 75	"	"			..		Wheat,	4	1 7	20 7	64	"			..			Wheat,	3	1 7	25 5	200	200
														Oats,	6	0 243									Oats,	4	243	4	243	243
														Barley,	8	4 13									Barley,	2 7	4 13	53 5	208	208
200	" "	2	1	5 625	11	12	11 5	"	"					Barley,	8	0·73	37	74	"	..					Barley,	3	0 73	5 5	200	100
														Wheat,	4	8·70									Wheat,	2	8 70	40·5	187	093
203	"	2	1	5 0625	11	18	11 5	"	"					Gram,	1	2 11	20	100	"						Gram,	1	2 11	10	0 211	105
														Gujal,	2	1·43									Gujai,	1	1·43	5	0 286	143
														Wheat,	3	4 98									Wheat,	2	4 98	57	0 174	087
207	"	3	1	5 5125	16 6	21	18 8	Matyar,	Cotton,	2	3 57	7 14	20	Barley,	3	5 54	39 32	111	Cotton,	1	3 57	11	824	102	Barley,	2	5 54	31	357	179
														Wheat,	4	3 50									Wheat,	2·7	3 5	24 5	386	193
														Tobacco,	10	0 57									Tobacco,	1	0 57	1	570	285
														Opium,	10	0 80									Opium,	4	0 30	2 8	460	230
211	"	1 5	2	5 7037	15·5	16 5	16·0	"	"	2	2 43	4 86	7	Barley,	3	3 83	39 5	56	"	1	2 43	4 2	200	193	Barley,	2	3 83	13 5	283	188
														Gujal,	3	1 71									Gujai,	2 3	1 71	6 2	293	195
														Wheat,	4	2 03									Wheat,	2 6	2 03	8 0	330	220
														Opium,	10	0 2									Opium,	5	0 2	2 5	200	133
														Tobacco,	10	1 28									Tobacco,	1	1 28	3 5	256	171
217	"	3	1	7·0875	12	19 6	15·8	Dumat,	"					Barley,	2	8·75	58	69	"		..		..		Barley,	2	8 75	50	350	117
	"	3	1	6·75				"						Wheat,	3	10 9									Wheat,	2	10 90	64	350	118
														Gram,	1	2 8									Gram,	1	2 80	10	280	·093
221	Kill, 2 pairs of cattle generally used,	1	1	6 6375	0	20	17 5	"	"					Barley,	2	4 01	44 5	104	"						Barley,	1 6	4 91	28	341	170
														Wheat,	3	11 34									Wheat,	2	11 34	76	300	150
														Oats,	6	114									Oats,	2	114	2	·114	114
225	Kill,	x	3	..	20		..	"	"					Peas,	2	1 86	93	186	"			..			Peas,	1 6	1 86	5	108	x
														Barley,	3	7 48									Barley,	2	7 48	30 5	167	x
														Wheat,	5	13·57									Wheat,	2·75	13 57	76	164	x

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL. WORK. Duration of work, minutes	No. of lifts	*Cubic feet lifted* Per pair of cattle per hour.	Per lift, per hour	Total per well.	*H P* Per bullock.	Total per well.	Length of watercourse.	*Area Irrigated.* Crop.	Watering	Interval.	Area in square feet.	*Depth* On area.	Of damp	*Days to an Acre.* Per pair of cattle	Per lift.	Per well.	Duty per pair	COST. *Annual* Interest at 5 p. c.	Repairs, &c.	Total.	*Per Acre* Per acre irrigated	Lifting	Total.	Remarks.
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
188	592	{ 785 { 588	111 151	111 302	2,174 2,957	655 875	388 518	} 660	Wheat, .	3	30 days	33,300	154	7	5 8	4 0	1 3		12 9	19	31 9				
192	577	1,002	150	150	2,880	880	508	220	Wheat, .	3	30 days,	5,630	5	66	15 5	15 5	7 75		5 8	12 0	17 3				
195	.					.		.	"	3	.	8,712	.		10·0	10 0	5 0		0 8	8 0	8·8				
196	474	385	260	269	2,132	1·469	690	{ 780 { 780	Oats, Barley, .	5 3	30 days, 30 days,	4,776 9,167	152 152	·5 5	} 3·1	3 1	3 1	..	10·1	9 0	19 1				
200	480	292	114	220	1,642	850	150	420	"	3	30 days,	10,000	155	·75	8 2	4 1	2 0		7 0	9 0	16 6				
203	382	381	133	266	1,691	612	234	1,260	Wheat,	3	30 days,	8,708	194	62	10 0	5 0	5	.	5 1	12·0	17 1				
207	352	600	205	616	3,638	1 103	388	610	"	3	37 days,	15,440	235	75	8 40	2 82	2 82		10 1	10 1	20·1				
211	387	667	230	345	3,865	955	322	980	" .	3	45 days,	30,540	126	10	4 26	2 84	1 42		7·8	17·0	24 8				
217	540 .	560 618	148 160	443 480	4,093 4,374	727 800	397 432	300 1,600	Barley, . Wheat, .	2 2	60 days, 30 days,	17,082 16,557	200 200	80 75	7 5 7 8	2 5 2 6	} 1 3		7 8	21 0	28 8				
221	490	501	405	405	8,325	2·052	1,005	480	"	2	30 days,	18,603	18	80	2 33	2 33	2 33	.	5 1	13 0	18 1				
225								"	"	"		22,000				6	2		18 0	31 0	44 0				

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number	Province	District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Percentage uncultivated: Waste	Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Double cropped area in acres	Total area actually cultivated in the year	STATISTICAL. Percentage of Total Cultivated Area: Wet	Dry	Kharif Wet: Wells	Kharif Wet: Canals	Kharif Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi Wet: Wells	Rabi Wet: Canals	Rabi Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Dry bricks	Kucha	Total	Lifts: Leather bucket	Earthen pots	Total	Usual labor for lifting buckets	Average area per lift in acres: Kharif	Rabi	Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	29	23	24	25	26	27	23	29	30	31	32	33	34	35	36
	N W P	ALIGARH	Hathras,	Bijarl,	1879-80	873·2	26 44	5·97	67 59	85·4	675 54	35·5	64 5	14·5		.	48·2	62·7	21 0		..	16 8	37 3	1	..	49	50	37		37	Bullock,	2 64	3 82	3 46	
					80 81	873 2	26·40	5·1	68·5	123·97	722·03	37·7	32 3	17 3	..	..	42 5	59·8	20·4		..	19 8	40·2	1	.	73	74	37		37	"	3 38	4·00	7·38	
			"	Ramupur,	79-80	441·4	19·85	10 9	69 25	80 77	386	55·0	45 0	13 2			37 8	51 0	41 8	.	.	7 2	49·0	2	..	42	44	25		25	"	2 07	6 56	8 63	
					30 81	441·4	19 85	8 9	71 25	112 77	427 27	60 7	39 3	16·0	.		35 0	51·0	44·7		..	4 3	49·0	2	..	42	44	25		25	"	2·37	7 6	10 27	
259			Iglas,	Sitapur,	79 80	469 17	4 2	4 0	91 3	21 3	451 8	24 6	75·4	.		..	51 8	51 8	24 6	-	.	24 1	48·7	3 p-2	..	1 p-3	5	19		19	"		5·80	5 80	Splendid springs.
					30 81	469 17	1 2	4·0	91 8	22·63	453 23	32 8	37 2	9·4	.		45·9	55·3	23·4			21 3	44·7	3 p 2	..	1 p-4	6	20	.	20	"	2 12	5 3	7·42	" "
268			"	Iglas,	79 80	469 94	13 5	5 5	81 0	58·1	438 7	44·1	55·9	9 1		.	40·4	49 5	35·0	.	..	15 5	50·5	4 p 3 2 p-3 1 p 1	..	1 p 16	23	35		35	"	1 11	4 38	5 49	W S fallen 3' within last 5 years
					80 81	469 94	13 5	5 6	80·9	51 9	432 9	47 5	52 5	13 6			38 2	51 3	38 9		..	14·3	43 2	4 p-2 2 p-3 1 p 1	2 p-1 .	1 p-34	40	51	..	51	"	1 14	2 88	4 02	" "
270			"	"	79 80	4137 66	17 9	13 1	69·0	885 26	3667 66	60·28	39 72	23·5	..	1 3	30·0	54·8	35 4	..	0·08	9 72	45 2	4 p-4 3 p-1 2 p 9 1p-53	1 p-46	1 p 185	308	226		226	"	3·7	5 5	9·2	" "
					80-81	4137 66	17 6	15 3	66 6	647 5	3382 1	37 3	32·7	22 0	..	5·0	23·3	50·8	40·0	.	3 3	9·4	49 7	"	1 p 29	1 p-133	299	223	..	226	"	3·3	6·4	10·0	" "

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well	*Class*	*Cost*: Construction	Fittings	Total	Renewal	Lifts	Yearly repairs	Total	*Supply*	*Quality*	*Substratum*	*Cultivators on well*: Number	Caste	*Labor and cost per day in annas*: Men, home	Do hired	Rate, per day	Cattle	Cost for men	Do for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
229	3	2	82	141	Masonry,	200/	3/	203/		10/	4/	14/	Percolation,	Sweet,	Sand,	4	Chamars, Chamars,	2		.	2		.	/14/
231				130	Kucha lined,	12/	5/	17/	3/	10/	1/	14/	Spring,	„	Clay 37',	2	Lodhas,	2	1	2	4	5	9	
281	3	2	82	114	Masonry,	300/	10/	310/		9/	1/	28/	„	„	„ 40',	5 1	Lodhas Herdsman,	6			4	5	6	-/11/
238	4	2	82	237	Kucha lined,	9/	3/	12/	3/	8/	1/	12/	„	„	„ 30',	1	Bania,		2 1	1 5 5	2	3 5	3	/6/6
242	4	2	82	235	„ „	5/	2	7/	2/	9/	1/	12/	„	„	„ 30,	2	Musalman,	1	2	1 5	4	3	6	/9/
248	4	2	82	8	„ „	4/-	2/	6/	1/	0/	1/	11/	„	„	„ 40',	1	Jat,	1	1	1 5	2	2 5	3	/5/6
251	5	2	82	145	„ „	9/-	2/-	11/	0·5	9/-	0 5	10/	„	Slightly Khatta	„ 32',	1 2	Jat, Brahmins,	1	1 2	1 2	4	4	6	/10/-
255	5	2	82	160	Masonry,	200/	4/	204/	.	8/	1/	17/	Percolation,	Sweet,	Sand,	1 1 1	Brahmin, Jat, Chamar,	2 2	1 1	2 2	2 2	3 3	3 3	-/6- '6/-
259	9	2	82	64	„	800/	20/	820/	.	9/-	1/	64/	Spring,	„	Clay 78',	1 2 3	Poet, Brahmins, Herdsmen,	14	3	1 5	28	17 5	42	3/11/6
265	9	2	82		„	800/	20/	820/-		9/	1/	73/	„	„	„	x	Brahmin,	18	5	1 5	32	19 5	48	4/3/6
268	9	2	82	200	„	400/	10/	410/	.	9/	1/	37/	„	„	„	2 1 2 1	Kachis, Brahmin, Herdsmen, Fakir,	4 4			4 4	3 3	6 6	-/9/- -/9/
275	11	2	82	243	„	300/	6/	306/		8/	1/	17/-	„	„	„ 45',	5 1	Musalmen, Lodha,	2	3	1·5	4	5 5	6	-/11/6

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL — Run: Class	Pairs of cattle to each lift	Lift: Number	Content in cubic feet	Depth to Wells: Morning	Evening	Mean	Soil	COMMAND — Kharif 1881 82: Crop	Waterings required	Area	Total area reduced to one watering	No of days to area	Rabi 1881 82: Crop	Waterings required	Area	Total area reduced to one watering	No of days to area	AREA IRRIGATED TO DATE — Kharif 1881-82: Crop	Waterings given	Area	Working days to date	Duty: Per lift	Per pair	Rabi 1881-82: Crop	Waterings given	Area	Working days to date	Duty: Per lift	Per pair
62		63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
229	Kill,	1	1		17			Dumat,						Kurr,	3	0 6									Kurr,		0 6	..		
231	„	2	1	6 637ɔ	17	24	20 5	„	Cotton,	2	3 17	6.84		Peas,	2	1 51	65	110	Cotton,	1	3 17	11 5	188	092	Peas,	1	1 51	6	126	084
														Barley,	3	7 17									Barley,	2	7 17	42	171	113
														Wheat,	5	7 86									Wheat,	2	7 86	44	178	119
231	„ 34',	1	1	6 75	18	20	19	„						Gram,	1	1 14									Gram,	1	1 14	1.7	224	224
		1	1	4 612ɔ				„	„					Barley,	3	5 08	65 7	111	„						Barley,	2	5 03	15	223	223
		1	1					„						Wheat,	5	7 34									Wheat,	3	7 34	30	244	244
														Tobacco,	10	1 28									Tobacco,	2	1 28	23	371	871
238	„ „	1	1	5.5	26	28	27	„	„					Barley,	4	1 12	8 68	58	„						Barley,	3	1 12	36	162	162
														Wheat,	5	0 83									Wheat,	3	0 83		162	162
242	„	2	1	6 86	26	31	28 5	„	„					Tobacco,	6	0.8			„						Tobacco,	2	0 8	4	400	200
														Potatoes,	4	1 1									Potatoes,	4	1 1	16	275	137
														Wheat,	5	2 71	35	100							Wheat,	3.8	2.71	34	302	151
														Garlic,	10	1 0									Garlic,	6	1 0	18	333	166
														Kurr & Carrots	3	0 83									Kurr & Carrots,	3	0 83	6	415	207
248	„	1	1	6 6375		38		„	„					Barley,	4	4 9	39	263	„						Barley,	4 8	4 9	106	222	222
														Wheat,	5	3 9									Wheat,	3.5	3.9	47	290	290
251	„	2	1	7 14	38	40	39	„	„					Barley,	3	1.43			„						Barley,	3	1 43	12	357	178
														Wheat,	4	3 68	21 45	120							Wheat,	3	3 68	36	302	151
														Carrots & Kurr	4	0 66									Carrots, Kurr,	4	0 66	8	330	165
25ɔ	„	1	1	6 75	39	51	45	„	„					Kharfa,	4	1 0									Kharfa,	1	1 0	2 5	200	200
	„	1	1	6 24				„						Wheat,	4	3 52	28 46	78	„						Wheat,	3	3 52	27 5	192	192
														Barley,	3	3 46									Barley,	2 2	3 46	16 0	238	288
2ɔ0	„ 8p	2	7	6 1425	23	36	29 5	Sandy Dumat	„					Barley,	2	1 03									Barley,	2	1 08	91	323	161
														Barley & Peas,	2	9 94									„ Peas,	1.4	9 94	8 7	228	114
														Gujai,	3	2 65	11 8	97	„						Gujai,	1	2 65	1 37	276	138
														Wheat,	3	27 2									Wheat,	2	27 2	35 5	219	110
														Carrots & Kurr,	5	1.32									Carrots, Kurr	2	1 34	1 5	255	127
265	„ 8p	2	8	6 2	23	40	31 5	Dumat,	„					Rabi,				•	„						Rabi,					
269	„	1	2	5 74	17	29	23	„						Barley,	2	4 5									Barley,	2	4 5	12	187	187
	„	1	3	6 27	17	29	23	„	„					Gujai,	3	3 4									Gujai,	2	3 4	6.8	213	213
														Wheat,	3	9 9	94	131	„						Wheat,	2 66	9 9	41	160	160
														Carrots & Kurr,	5	1 26									Carrots, Kurr,	5	1 26	9	175	175
														Tobacco	10	3 09									Tobacco,	6 4	3.03	25	193	193
														Garden,	10	0 9									Garden,	5	0 90	5	225	·225
27ɔ	„	1	2	5 23	31 5	31	32 75	„	„					Gram & Kurr,	1	0.23									Gram & Kurr,	1	0 23	1	115	115
														Barley & Peas,	3	11 80	49.7	75	„						Barley, Peas,	2 47	11 80	78	191	191
														Wheat,	3	5 2									Wheat,	2 38	5 2	26	238	238

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL. WORK		Cubic feet lifted.			H P			Area Irrigated				Depth.		Days to an Acre				COST Annual			Per Acre			Remarks.
	Duration of work, minutes.	No of lifts.	Per pair of cattle, per hour	Per lift, per hour	Total per well.	Per bullock.	Total per well.	Length of watercourse	Crop	Watering	Interval.	Area in square feet.	On area.	Of damp	Per pair of cattle.	Per lift.	Per well.	Duty per pair	Interest at 5 p c	Repairs, &c.	Total.	Per acre irrigated.	Lifting	Total.	Remarks.
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
220	·	·	..		·	·	·	·	..	·		·	·	..	..	..	1 7		11·0	28·0	30 0				
231	501	858	141	282	2,375	801	481	400	Wheat,	3	30 days,	15,045	15	·70	5·4	2 7	2 p	..	..	·	·				
231	552	380	279	279	2,505	1 407	770																		
	400	318	180	180	1,464	916	448	700	Barley,	3	30 days,	15,300	21	10	4 5	4 5	1 7	..	15 5	28·0	43 5				
								320	Tobacco,	2	"	3,830	21	1 10			3 p								
238	428	231	170	170	1,270	1 270	545	300	Barley,	3	35 days,	6,830	18	8	6 2	6 2	6·2	·	0·6	12·0	12 6				
242	407	280	137	254	1,082	1·000	407	150	Wheat,	3	60 days,	6,324	120	60	5 7	2 85	2 85	..	0·4	12·0	12 4				
								320	Garlic,	6	15 days,	8,480	120	75											
248	..	·	..	..	·	·	·	470	Wheat,	4	..	6,446	·	·	0 75	0 75	0 75	·	0 8	11 0	11 8				
251	590	809	145	200	2,850	1 471	868	140	Barley,	3	60 days,	2,640	·38	60	11 2	5 6	5·6	..	0 6	10 0	10 6				
								460	Wheat,	3	60 days,	5,000	38	80											
256	459	220	106	106	1,485	2 574	1,166	800	Khurfa,	2	6 days,	12,600	118	9	3 5	3 5	2 0		10 2	17·0	17 2				
	480	216	108	108	1,848	2 223	1,067	580	Barley, ..	2	30 days,	4,874	3	85	10	10									
260	480	2,261	126	252	13,888	1 145	550	1,050	Wheat,	2	30 days,	52,758	259	·75	11 5	5·7	8 25		41 0	64 0	10 5				
265	480	2,400	116	232	14,880	1 200	574	1,500	Wheat,	2	·	22,600	27	80	12 0	6 8	8	..	41 0	73 0	11 4				
								500	Barley,	2	·	31,828	27	·90											
268	540	782	238	238	4,200	1·722	930	1,500	Wheat,	3	60 days,	13,420	31	75	6·4	6 4	1·4	..	20 5	37	57 5				
	540	774	270	270	4,858	2 000	1,079	1,000	"	3	60 days,	17,090	31	80	4 9	4 9									
275	510	714	220	220	3,781	1·925	982	650	Barley, Peas,	3	60 days,	26,842	180	1 0	3 24	3 24	1·62		15 3	17 0	32 3				

TABLE A — *Observation and Experiment*—(Continued)

STATISTICAL.

Serial Number	Province	District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Area in Acres: Percentage uncultivated: Waste	Area in Acres: Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Cultivated Area: Double cropped area in acres	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Percentage of Total Cultivated Area: Dry	Kharif: Wet: Wells	Kharif: Wet: Canals	Kharif: Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi: Wet: Wells	Rabi: Wet: Canals	Rabi: Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Irrigation Wells: Dry bricks	Irrigation Wells: Kacha	Irrigation Wells: Total	Lifts: Leather bucket	Lifts: Earthen pots	Lifts: Total	Usual labor for lifting buckets	Average area per lift, in acres: Kharif	Average area per lift, in acres: Rabi	Average area per lift, in acres: Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
287	N W P	MUTTRA	Sadabad,	Sadabad,	1879 80	984 25	12 4	9 8	77 8	45 15	811 10	14 7	85 8	0 4			61 8	62 2	14 8	..	.	23 5	37 8	2 p-2 1 p-7	1 p-1	1 p 72	82	48		48	.	0·05	2·42	2·47	
			"	"	80 81	984 25	12 2	0 3	78 5	73 22	845·4	80 7	69 3	8 1		.	49 4	57 5	22 6			19 9	42 5	2 p-3 1 p 7	1 p 1	1 p-79	89	50		50	..	1 38	3 83	5 21	
296			"	Munnla,	79 80	907 81	4 3	2 6	93·1	41 72	971 20	43 6	56·4	2 3	.		47 4	48 7	41 8			9·0	50·3	3p 2 2p-3	1p 1	1p 153	180	66		66	.	0 84	6·08	6·42	2 pairs of cattle per lift generally used
			"	"	80 81	997 81	4 3	1 8	93·9	54 89	991 57	63 7	86 8	21 5			29 5	51 0	42 2			6 8	49·0	1p 1 "	1p-1	1p-135	142	63		63	.	3 37	6 63	10 60	W S" fallen "6′
300			Mahában, "	Narhauli, "	79 80 80-81	478 21	6 9	9 7	83 4	11 83	415 2	35 3	64·7	11 6		3 0	57 7	61 3	21 7			7 0	29·7	. 2p 2 1p 2	.	. 1p 50	. 54	31		31	..	. 1 54	2 91	4·45	W S fallen lately
307			"	Chauli,	79-80	981 30	19 9	2 7	77 4	7 9	767 5						71 7		18·0			10 3		2p 1	.	49	50	80		30			4 61	4 61	" "
307			"	"	80 81	981 30	20·4	7 4	72 2	6 7	714 5			4·7			62 2		20 9			12 2	.	2p 1	..	60	61	35		35	.	1 00	4·27	5 27	" "
312			"	Gonga, ..	79 80	509 88	9 4	2 2	88 4	32 9	483 42	33·1	66 9				57 3	57 8	33 1			9 6	42 7	2p-1 1p 12		2p-3 1p 44	60	64		64	..		2 5	2 5	W S fallen 15
					80 31	509 88	9 4	2 2	88 4	44 31	494 83	41 2	58 8	10·9			44 9	55 8	30 3			18 9	44 2	"		"	60	64		64	..	0·84	2 34	3 18	" "
			"	Bhinla,	79 80	293 85	4 1	1 7	94 2	15 20	292·02	22 1	77 9	0·6			63 2	63 8	21 5			14 7	36 2	2p 4		1p 10	16	22		22		0·07	2 86	2·93	" "
					80 81	293 85	4 0	0·9	95 1	30·80	310 20	30 9	69 1	7 8			55 7	63 0	23·6			13 4	37 0	2p 3		1p 32	25	28		28	..	0 81	2 61	3 42	" " " "

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE.

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well.	*Class*	*Cost*: Construction.	Fittings.	Total	Renewal	Lifts.	Yearly repairs.	Total	*Supply*	*Quality*	*Substratum*	*Cultivators on well.*: Number	Caste	*Labor and cost per day in annas.*: Men, home	Do. hired	Rate, per day	Cattle.	Cost for men	Do. for cattle.	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
270	11	2	82	240	Masonry, 1st year,	300/	8/	308/	..	9/	1/	10/-	Spring,	Sweet,	Clay, 45',	1	Lodha, .	2	1	1 5	4	2 5	6	/8/6
289	11	2	82	190	Kucha unlined, 4 years' old,	5/5	/5/	6/	.	9/	1/	10/	" .	" ..	"	3 1	Musalmen, . Carpenter,	.	1 1 1	1 5 1 0 0·5	4	3	6	-/0/-
287	6	2	82	224	Kucha lined with wood, 3 years' old,	21/5	4/	24/5		10/	1/	11/	"	Slightly Kharra,	" 50', ..	1	Brahmin,		2 1	1 75 5	2	4	3	/7/
291	6	2	82	118	Kucha lined with wood, 15 years' old,	21/5	4/	24/5		8/	1/	9/	" .	" .	" 50', .	1	Gujar,	1	2	1 5	2	3	3	-/6/-
294	6	2	82	63	" " new,	21/5	4/	24/5		8/	1/-	9/-	" .	"	" 48', .	1	Brahmin, .	3	..	..	2	2	3	/5/
296	6	2	82	1,708	Masonry, 200 years' old,	400/	0/	400/		8/	1/	17/	" .	Slightly Kharra,	"	4 1	Jats, Brahmin,	2	5	1 5	4	8 5	6	/14/6
300	7	2	82	870	Masonry, old, .	400/-	0/	400/-		8/	3/	19/	Percolation,	Kharra, .	Sand, .	2	Brahmins, .		5	2 0	4	1·0	6	1/
304	7	2	82	385	Kucha lined, 9 months' old,	7 5	1 5	9/	1/	8/	1/	10/	"	Sweet, .	" .	1	Brahmin, ..	1	2	1 3	2	2 5	3	/5/8
307	7	2	82	1,221	Masonry, 60 years' old,	1000/	0/	1000/-	..	9/	1/	10/	Spring, .	Kharra,	Clay, 78,	1	Jat,	1	2	1.3	4	2 6	6	/8/-
																1	" ..		2 1	1 3 1 0	4	3.6	6	/9/8
312	8	2	82	8,407	Masonry, ..	800/	3/	803/-		8/-	10/	18/	Percolation was spring,	Sweet,	" 68', .	1	Byragi,		2	1·5	2	3 5	3	-/6/6
315	8	2	82	6,010	Kucha lined, 3 years' old,	6/	2/	8/	1/	9 5	1 5	11/	Spring, .	"	" 68',	1	Brahmin,	3	1	1 0	4	2	6	-/8/-
319	8	2	82	6,018	Masonry,	400/	4/	404/		8/	3/	19/	Percolation was spring,	"	" 68',	1 2	Jat, Brahmins,	2	2	1 5	4	4	6	/10/

TABLE A —*Observation and Experiment*—(Continued)

EXPERIMENTAL.

COMMAND

Serial Number	Run: Class	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil.	*Kharif* 1881-82: Crop	*Kharif* 1881-82: Waterings required.	*Kharif* 1881-82: Area	*Kharif* 1881-82: Total area reduced to one watering	*Kharif* 1881-82: No of days to area.	*Rabi* 1881 82: Crop	*Rabi* 1881 82: Waterings required	*Rabi* 1881 82: Area.	*Rabi* 1881 82: Total area reduced to one watering	*Rabi* 1881 82: No. of days to area.
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
279	Kill, 6 5 *d*,	2	1	5 7375	34 8	36	35 4	Dumat,	..	..				Barley,	3	0 23	34 8	100
														Wheat,	4	2 23		
														Carrots,	5	4 94		
283	"	2	1	..	27	28	27 5	"						Barley,	8	2 14	37 0	133
														Barley & Peas,	3	3 6		
														Wheat,	4	2 3		
287	"	1	1	7 65	49·5	53	51 25	Sandy, Dumat,			.	..		Barley,	4	1 37	25 13	100·5
														Guchana,	5	1·37		
														Wheat,	5	2 56		
291	"	1	1	4 725	46	52	49	"						Barley, Gram,	8	6 59	19 8	109
294	"	1	1	..		48	.	"	..					Barley,	4	1 54	14 66	102
														Wheat,	5	1 70		
296	Kill, 3*p*,	2	2		45	47	46	Dumat,	Sugar, Cotton, Indigo, &c.,			.		Barley,	4	8 00	85	90
														Wheat,	5	12 07		
														Carrots, Kurr,	5	2 55		
300	Lagor,	1	2	4 23	60	65	63 5	"	"		.			Barley,	8	0 73	27 8	194
														Wheat,	4	5 71		
														Kurr, Carrots,	5	0 57		
301	"	1	1	..		60		"	"		..			Barley,	2	4 07	12 28	86
														Wheat,	3	1 88		
307	Kill,	2	1	6 1875	65	69	67	Dumat and Matyar,	"				..	Wheat,	4	5 61	22·44	75
	"	2	1	5 4	65	69	67	"	"					Barley,	2	5 71	18 02	69
														Wheat,	3	2 20		
312	"	1	1	1 95	56	60	58	Sandy, Dumat,	"					Wheat,	4	4 2	17 1	114
														Garden,	10	0·03		
315	"	2	1	6·1875	56	61	58 5	"	"		.			Gujal,	4	1 10	7 75	26
														Wheat,	5	63		
														Garden,	10	02		
319	"	1	2	5 4	57	62	59 5	"	"					Barley,	3	2 73	380	182
														" & Peas,	3	1 06		
														Wheat,	5	4 72		
														Carrots & Kurr,	6	0 64		
														Garden,	10	0 02		

AREA IRRIGATED TO DATE

Serial Number	*Kharif* 1881 82: Crop	*Kharif* 1881 82: Waterings given.	*Kharif* 1881 82: Area.	*Kharif* 1881 82: Working days to date.	Duty: Per lift.	Duty: Per pair	*Rabi* 1881-82: Crop	*Rabi* 1881-82: Waterings given.	*Rabi* 1881-82: Area	*Rabi* 1881-82: Working days to date.	Duty: Per lift.	Duty: Per pair
	80	81	82	83	84	85	86	87	88	89	90	91
279	.	.	..	.		.	Barley,	3	0·23	25	276	138
							Wheat,	3	2 23	24	279	139
							Carrots,	3	4 94	36 5	406	203
283	.		.	..			Barley,	4	2 14	24	356	178
							" Peas,	2·4	3·6	27 5	314	157
							Wheat,	3	2 3	21 5	321	160
287	.	..			.		Barley,	3	1 37	21	196	196
							Guchana,	3	1 37	21	196	196
							Wheat,	3	2 56	34 5	222	222
291	..	..			.	.	Barley, Gram,	1	6·59	41	160	160
294							Barley,	2	1·50	20	154	154
							Wheat,	2 7	1 70	85	131	131
296				..	.		Barley,	2	3·00	6	338	166
							Wheat,	2 66	1·07	36	300	150
							Carrots, Kurr,	4 5	2 55	15 3	250	125
300	.			.			Barley,	2	·73	8	·091	091
							Wheat,	2	5 71	52	110	110
							Kurr, Carrots,	4 63	0 57	14	·094	·094
301	.		.	.	.	.	Barley,	2	4·07	50	163	163
							Wheat,	2	1 38	16	172	172
307	.					.	Wheat,	2 3	5 61	72	173	086
	.	..	.	.	.		Barley,	2	5 71	74	140	·070
							Wheat,	2	2 20	23	157	078
312	.			.			Wheat,	2	4 2	62 5	134	134
							Garden,	10	0·03	2 5	120	120
315	.	.		..	..		Gujal,	4	1 10	24	183	·091
							Wheat,	3	0·63	12	157	078
							Garden,	3	0·02	15	120	060
319	.	.	..	.	..		Barley,	2	2 78	18	151	151
							" & Peas,	3	1 06	15	106	106
							Wheat,	3	4 72	66	107	107
							Carrots & Kurr,	6	0 64	15	128	128
							Garden,	8	0.02	0 4	200	200

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL																								Remarks
	WORK																		COST						
			Cubic feet lifted			*H P*			*Area Irrigated*				*Depth*		*Days to an Acre*				*Annual*			*Per Acre*			
	Duration of work minutes.	No. of lifts.	Per pair of cattle per hour.	Per lift, per hour	Total per well.	Per bullock.	Total per well.	Length of watercourse.	Crop.	Waterings	Interval.	Area in square feet.	On area.	Of damp.	Per pair of cattle.	Per lift.	Per well.	Duty per pair.	Interest at 5 p. c.	Repairs, &c.	Total.	Per acre irrigated.	Lifting	Total.	
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
270	400	400	150	300	2,295	1 380	034	600	Carrots,	3	20 days,	15,207	15	70	5 8	2 0	2 9	.	15 1	10 0	25 1				
283			.		.	.	..		Rabi, ..	"	"	12,000			7 2	3 0	3 0	..	0 3	10·0	10 3				
287	460	194	193	193	1,481	2 607	1,200	194 100	Guchana, Wheat,	4 4	30 days, 30 days,	8,803 2,214	184 184	1 0 06	4	4	4		10 2	11·0	21 2				
291	55?	394	202	202	1,862	2 740	1,510	520	Barley,	1		7,811	238	00	5 5	5 5	5 5	.	10 2	0 0	19 2				
294	.	..		.	,		.	r	Wheat,	3		6,220	.		7	7	7	..	10 2	0 0	19·2				
296	.			.	..		..	450	Wheat,	3	..	41,400		80	6 3	3 15	1 05	..	20	17·0	37 3				
300	400	371	102	102	1,565	1 773	815	1,020	Wheat, .	2	07 days,	6,336	248	70	1 4	14	7		20 3	10·0	30 3				
301			.	.	..	.	.	500	Barley, .	2	..	6,120	.	60	7	7	7		0·4	10·0	10 4				
307	445	201	122	243	1,800	2·188	074	500	Wheat,	3	45 days,	18,024	138	50	6 7	3 84	3 84	}	50 1	19·0	69·4				
312	510	231	74	117	1,247	1 830	078	570	Wheat,	3	45 days,	10,017	124	00	8 7	4 83	4 83								
	525	281	181	181	1,148	2 070	1 087	120 80	Wheat, Garden,	2 10	00 days, "	5,681 820	170	1 10	6 7	0 7	6 7	.	15 1	18 0	33 1				
315	550	303	102	204	1,875	1 022	892	470 210	Gujal, Wheat, .	4 4	30 days, 30 days,	7,185 5,540	140	80 120	6 8	3·4	3 4		0 4	11 0	11·4				
319	010	401	122	122	2,400	2·000	1,312	940	Wheat,	4	30 days,	8,920	270	80	9 6	9 6	4 8	.	20 2	10·0	30 2				

TABLE A —*Observation and Experiment*—(Continued)

STATISTICAL

Serial Number	Province	District	*Locality* Pergunna.	*Locality* Village.	Year	*Area in Acres* Actual area in acres.	*Percentage uncultivated.* Waste.	*Percentage uncultivated.* Culturable.	*Cultivated Area.* Percentage of actual area cultivated	*Cultivated Area.* Double cropped area in acres.	*Cultivated Area.* Total area actually cultivated in the year	*Percentage of Total Cultivated Area* Wet.	Dry	*Kharif* *Wet* Wells.	*Kharif* *Wet* Canals	*Kharif* *Wet* Other sources.	*Kharif* Dry .	*Kharif* Total	*Rabi* *Wet.* Wells.	*Rabi* *Wet.* Canals.	*Rabi* *Wet.* Other sources	*Rabi* Dry	*Rabi* Total.	*Irrigation Wells* Lime masonry	Dry bricks.	Kucha.	Total.	*Lifts* Leather bucket.	Earthen pots.	Total	Usual labor for lifting buckets.	*Average area per lift in acres* Kharif.	Rabi.	Total.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	18	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	20	30	31	32	33	34	35	36
					1879 80	513.45	6 5	6 4	87 1	10.70	457.37	85 7	84.8	.	.	.	61 4	61 4	85.7		.	2 9	38 6	2 *p*-4	.	2 *p*-1 1 *p*-33	38	48		48	..		3 82	3.88	W S fallen 15'.
					80-81	513 46	6.5	6.6	86 9	21.49	467 07	44 1	55.9	14 5		.	47.0	61 5	20 6	.		8 9	38 5	2 *p*-4	..	2 *p*-5 1 *p*-31	40	49		49		1 89	2 82	4 21	" "
320			Dibai, ..	Bajatpur,	79 80					.		.		..		..		.			.		.	..	..	.	.				..		..	.	
			" ..	"	80-81	449 22	4 9	0 9	94 2	11.0	484 4	18 7	83.8	..	0 2		40 8	41 0	1 1	15 4	..	42.5	59.0	.	.	2 *p* 1 1 *p*-2	8	4		4	..	.	1 21	1 21	Kucha wells do not require any lining
331			Anúpshahr,	Anúpshahr,	79-80	1761 88	88 8	10 6	50 8	84 5	976.15	14 4	85 6	2.6	1 6	0 25	62 4	66 85	5.5	4 4	0.05	23.2	33 15	8 *p*-1 1 *p*-41	1 *p*-4	12	58	32	12	44		0 80	1 42 0 78	2.22 0 78	
			"	" .	80-81	1761 88	38.7	14 4	46 9	104.72	929 78	20.2	79 8	5 8	2.19	.	52.5	60 49	6.8	5.4	0.01	27.3	39 51	3 *p*-1 1 *p*-41	1 *p*-4	. 16	62	32	16	48	Men, Cattle, Men,	1 71 .	1 89 0.60	3.40 0.60	
316	N W P	BULANDSHAHR	" ..	Gynah,	79 80	.			..		..		.	.			.	..	..	.	.	.		..	..	..	.		.	.	..	.	.	.	
			" .	" .	80 81	1296 75	6 3	21.7	72.0	98	10 31	33.7	66 3	9 7			37.0	46 7	24 0	.	.	29 8	48 3	8 *p* 1 4 *p* 1 2 *p* 2	2 *p* 2	2 *p*-6 1 *p* 2	14	34		34	Bullock,	2 98	7 27	10 20	2 pairs of cattle per lift generally used
333			Burna, .	Chándpur, .	79 80	701 8	15.0	5.9	78 2	253 8	802.11	58 2	46.8	2.0	16.2		25 9	44 1	19.7	15 2	0.10	20 9	55.9	8 *p* 1	..	2 *p* 6 1 *p*-13	20	28	.	28	"	0.58	5 64	6 22	W S has risen 6' since canal was opened.
			" ..	" .	80 81	701 8	15 7	5.7	78 0	228 75	779.72	70.7	29 3	12.0	13 4	0.10	20 9	46 4	26 5	18.7		8.4	58 8	3 *p* 1	. . .	2 *p*-6 1 *p*-13	20	28		28	"	3 27	7 89	10.66	2 pairs cattle used.
359			" ..	Tatarpur, .	79 80	332.0	5.7	5 5	88 8	71 41	365 85	40 9	59 1	18 6	.		26.6	43 2	24 3	.	..	32 5	58 8		.	2 *p*-1 1 *p*-11	12	18	.	18	"	4 08	6.81	11.49	2 pairs of cattle per lift generally used.
			" .	"	80-81	332.0	6.1	1.4	92 5	88.37	395 37	58 6	46 4	19.1			22 5	41.6	34.2	.	0 3	28 9	58.4	..	..	2 *p*-3 1 *p* 14		..			"	..	.	10 52	

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE.

Serial Number	Date: Day	Month	Year	Number of Well	Class	Cost: Construction.	Fittings.	Total.	Renewal	Lifts.	Yearly repairs.	Total.	Supply	Quality	Substratum.	Cultivators on well: Number	Caste.	Labor and cost per day in annas: Men, home.	Do hired	Rate, per day	Cattle.	Cost for men.	Do for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
325	8	2	82	8,445	Kucha lined,	11/	6/	17/	.	7/	1/	15/-	Spring,	Sweet,	Clay,	1	Jat,	1	2	1 5	4	3	6	-/9/-
329	13	2	82	118 118	Kucha unlined, " "	3/ 3/-	3/ 3/	22/-	..	7/-	1/	15/	"	"	" 42',	1 2	Thakur, Lodhas,	3 3			4 4	4 ..	12 .	1/-
334	14	2	82	768	Masonry,	250/	3/	253/-		7/	1/	8/	"	"	"	1	Mali,	3			2	2	3	-/5/-
340	14	2	82	1,088	"	300/	9/	309/	..	7/	1/-	22/	"	"	" 30',	1	Mali,	3	1	1 5	8	3·5	12	-/15/6
																1	Musalman,		3	1 5	2	4 5	3	/7/6
346	15	2	82	510	"	300/	10/	310/		8/-	1/	25/	"	"	" 30',	1 1 3 9	Barber, Bania, Brahmins, Jats,	3		.	4	2	6	/8/
353	16	2	82	158	Kucha lined with wood,	37/	3/	40/-	..	8/	2/-	10/	"	"	" 27',	9	Lodhas,	3		.	4	2	6	/8/-
359	20	2	82	284	"	24/	6/	30/	3/	11/	1/	26/	"	"	"	1 2 6	Barber, Jats, Brahmins,	3	2	1 5	8	5	12	1/1/-

TABLE A.—*Observation and Experiment*—(Continued)

EXPERIMENTAL.

Serial Number	Run		Lift		Depth to Wells			Soil	Command: Kharif 1881 82					Command: Rabi 1881 82				
	Class	Pairs of cattle to each lift.	Number	Content in cubic feet.	Morning	Evening	Mean		Crop	Waterings required.	Area.	Total area reduced to one watering	No. of days to area.	Crop.	Waterings required	Area.	Total area reduced to one watering	No. of days to area.
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
														Barley, .	2	0·32		
325	Kill, .	1	2	4 80	56	62	59	{ Sandy, . Dumat, .	..		..	.	..	,, & Peas,	2	0·46	217	56
														Gujal,	3	0 71		
														Barley, Peas,	2	3 56		
329	,, .	2	1		30	..		,, .						Guchana,	3	2 25		
	,, .	2	1	.	30	.	..	,,	..	.	.		..	Gujal,	3	3 65	39	101
														Wheat,	4	3 56		
														Gujal,	2	1 347		
														Tobacco,	4	0 625		
331	,, .	1	1	..	37	41	39	,, .	.		..	..	.	Cauliflour,	7	0·031	14	66
														Egg plant,	7	0 156		
														Melons, .	8	0 987		
310	,,	2	2	..	31		.	,, .	{ Cotton,	1	1 31			{ Wheat, .	0	5 06		
									{ Sugar,	4	0 48			{ Oats, ..	0	0 22		
												4 16	11 25	{ Garden,	10	3 37		
	,, .	1	1	..	34	.	..	,, .	,, .	3	0·31			{ Barley,	5	0 48	75·0	113
														{ Wheat, .	6	1 105		
														{ Oats,	6	0 20		
														Barley,	4	3 84		
														Wheat,	7	4 5		
316	,, 3 p, ..	2	1	6·6	21 5	26	23·75	,, .	Cotton,	3	2 2	6 6	8	Oats, ..	7	0 07	105	141
		2	2	.		.								Kurr,	9	12 00		
														Tobacco,	15	1 125		
														Garden,	10	0 47		
														Barley,	3	2 3		
353	,, ..	2	1	..	11	.	.	,,	,, .		.	.	..	,, Peas,	3	3 17	37	148
														Gujal,	4	0 65		
														Tobacco,	9	0 72		
														Garden,	7	1 875		
														Gram,	2	2 56		
														Barley,	3	0 23		
														,, & Peas,	3	1 56		
359	,,	2	2	5·57	27	27	27	,, .	,, .		..	.		Gujal,	4	1 635		
														Wheat, .	4	5 53	84	160
														Guchana,	3	2 65		
														Peas,	2	0 56		
														Tobacco,	8	3 0		
														Garden,	7	1 65		

Serial Number	Area Irrigated to date: Kharif 1881-82.						Area Irrigated to date: Rabi 1881 82					
	Crop	Waterings given.	Area.	Working days to date.	Duty: Per lift.	Duty: Per pair	Crop	Waterings given	Area	Working days to date.	Duty: Per lift.	Duty: Per pair
	80	81	82	83	84	85	86	87	88	89	90	91
							Barley,	1	0 33	3	086	080
325	..	.	..	..			,, & Peas,	1 17	0 16	63	080	080
							Gujal,	2	0 7	5	112	142
							Barley, Peas,	1 56	3 58	10	277	138
329							Guchana,	2	2 25	10	225	112
	..			.	..		Gujal,	1	3 65	10	182	091
							Wheat,	2	3 56	20	178	·089
							Gujal,	1	1 347			
							Tobacco,	2	0 625			
331			..	.	.		Cauliflour,	4	0 031	18	0 212	0 212
							Egg plant,	7	0 156			
							Melons,					
310	{ Cotton,	1	1 31	2 5	0·200	0·137	{ Wheat,	4	5 06	51	206	100
	{ Sugar,	4	0·48	5	0·102	0·096	{ Oats,	3	0 22	1 5	330	165
							{ Garden,	5 48	3 37	48	209	104
	Sugar,	3	0 31	3·75	0·250	0·250	{ Barley,	3	0 48	5 25	274	274
							{ Wheat, .	3	1 165	12 75	266	260
							{ Oats,	3	0·20	2 25	266	266
							Barley,	2 86	3 84	2 5	147	073
							Wheat, ..	3 64	4 50	40	138	069
316	Cotton, .	3	2 2	12	183	691	Oats,	3	0 07	·4	175	087
							Kurr,	2	12 00	5 7	·140	·070
							Tobacco,	1 11	1 125	2 7	155	077
							Garden,	6	0 17	8	120	060
							Barley,	2	2 3	15 5	300	150
353	..	.	.		.		,, Peas,	1 53	3 47	22	241	120
							Gujal,	2	0 65	0	216	108
							Tobacco,	2	0 72	4	360	108
							Garden,	3	1 875	2 0	281	140
							Gram,	2	2 56	14	183	091
							Barley,	3	0 23	5	410	220
							,, & Peas,	2	1 56	5	312	156
359							Gujal ..	3	1 625	7 16	340	170
	..	..	.		.		Wheat,	2 15	5 53	20 14	136	168
							Guchana, .	1	2 65	7	188	·094
							Peas,	1	0 56	1	280	140
							Tobacco,	1	3 0	3 5	128	214
							Garden, ..	4	1 65	8	412	206

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL. WORK. Duration of work, minutes.	No of lifts.	*Cubic foot lifted.* Per pair of cattle, per hour	Per lift per hour.	Total per well.	*H P* Per bullock.	Total per well.	Length of watercourse	*Area Irrigated* Crop	Watering	Interval.	Area in square feet.	*Depth.* On area.	Of damp	*Days to an Acre* Per pair of cattle.	Per lift.	Per well.	Duty per pair	COST *Annual* Interest at 5 p c	Repairs, &c.	Total	*Per Acre* Per acre irrigated	Lifting	Total	Remarks.
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
325	555	582	140	140	2,600	2·288	1,267	550	Barley, Peas,	2	60 days,	16,624	167	1 2	6 2	6 2	2 6		0·8	15·0	15 8				
329	.	.	..		..			.	Rabi, ..	2	60 days,	10,764	..	..	10·4	6·2	2 0	..	0·8	15·0	15 8				No experiment on account of rainfall.
334	.	.	..	..					Garden, .	9	..	9,281	.		4 7	4 7	4 7		12·0	8·0	20·0				" "
340	..	..	..	.		..	..	..	Rabi, .	3	.	18,255	.	..	9·6	4 8	1 5	..	15·4	22·0	37 4				" "
	.	.	..	..	..	..	..	..	Rabi,	3	..	11,210	.		4·0	4·0									
346	400	425	190	880	2,550	1 271	508	790	Tobacco,	1	..	10,700	·21	60	8·0	4	1 3		15 1	25 0	40 0				Only one lift at work as rain had recently fallen.
353	..	..	..	.		.		..	Rabi, .	2	.	10,311	.	..	8·0	4 0	4 0		2 0	10	12·0				
359	680	620	82	105	9,453	600	372	810	Garden, ..	5	25 days,	22,680	15	14	7 0	0 8	1 9	.	1·5	26	27 5				

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	Province	District	Pergunna	Village.	Year	Actual area in acres.	Waste.	Culturable.	Percentage of actual area cultivated.	Double cropped area in acres	Total area actually cultivated in the year	Wet.	Dry	Kharif Wet Wells	Kharif Wet Canals.	Kharif Wet Other sources.	Kharif Dry	Kharif Total	Rabi Wet Wells	Rabi Wet Canals.	Rabi Wet Other sources.	Rabi Dry	Rabi Total.	Irrigation Wells Lime masonry	Dry bricks.	Kacha.	Total	Lifts Leather bucket.	Earthen pots.	Total.	Usual labor for lifting buckets.	Average area per lift, in acres Kharif.	Rabi.	Total.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
374	N. W. P.	BULANDSHAHR.	Barna,	Jasnauli,	1879 80	711·43	0 5	7 4	83·1	21 2	611 92	1 1	98 9	·			42 0	·	1 1			56 9	·	3 p 1	3 p-2	··	8	6		6	Bullock,	··	1 1	1 1	
376			"	"	80 81	711 43	0·5	7 4	83 1	25 25	615·97	9·8	90 2	8 6	·	0 7	82 9	·	5 2	·	0 3	57 8	·	3 p-1	3 p-2	··	8	6		6	"	3 0	5 35	8 95	2 pairs of cattle per lift generally used
381			"	Bulandshahr,	79-80	5179 3	8·7	22 0	68 4	1219·0	4758·8	53 8	46·2	8 6	16 0		20·8	45·4	21 8	7 4	·	25·4	54 6	2 p-25 1 p-18	1 p 17	2 p 26 1 p-43	129	180		180	"	2 86	5 73	8·09	" " "
			"	"	80-81	5179 3	12 1	15·2	72 7	1955 47	5721 47	76 2	23·8	8 4	20·2	0 02	7 8	85 92	16 5	31 08	·	16 5	56·08	2 p 25 1 p 18	1 p-17	2 p 26 1 p-48	129	180		180	"	2 68	5 27	7 95	" " "
391			Agoutah,	Aoledah,	79-80	1525 0	0 2	15 9	77 9	130	1,318	36 2	63 8	5 7	8 2	0 3	21 4	35 6	5 3	16 2	0·5	42·4	64·4	2 p 7 1 p 15	··	·	22	29		29	"	2·6	2 4	5 0	" " "
			"	"	80 81	1525·0	6·9	15·4	78 3	246 75	1,445	78·9	21 1	13 6	19·6	0 4	15·7	49 3	19·0	25 8	0 5	5·4	50 7	2 p 9 1 p-10	··	·	19	28		28	"	7 0	9 72	16 72	W " S " raised 3' since Canal was opened
406		MEERUT	Hapur,	Hapur,	79 80 80-81	2564 0 2564 0	15 3	22 9	61 8	320·78	1,905	22·9	77 1	0 2	·	·	48·7	48·9	23 5		0 2	28 4	51 1	2 p-3	·	2 p-3	185	125	·	125	"	0·02	3 41	3·43	

TABLE A —*Observation and Experiment*—(Continued)

DESCRIPTIVE.

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well.	Class	Cost: Construction.	Cost: Fittings.	Cost: Total.	Cost: Renewal	Cost: Lifts.	Cost: Yearly repairs	Cost: Total.	Supply	Quality	Substratum	Cultivators on well: Number	Cultivators on well: Caste	Labor and cost per day in annas: Men, home	Do hired	Rate, per day	Cattle.	Cost for men	Do for cattle.	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
369	20	2	82	215	Kucha unlined,	5 5	3/	8·5	5 5	8/	..	185/	Spring,	Sweet,	Clay, ..	1 1	Musalman, Brahmin,	1	2	2·0	4	4	0	/10/-
374	21	2	82	193	Masonry,	300/	6/	306/	..	7/	1/	15/	„	„	„	12 2	Jats, Chamars,	4	2	1 5	8	6	12	1/2/-
381	2..	2	82	187	Kucha, lined with wood,	32/	3/	35/		9/	1/	10/-	„	„	„	1	Lodha,	2	1	1 5	4	2 5	0	-/8/6
386	22	2	82	354	„ „	32/	3/	35/		9/	1/	10/	„	„	„	8	Lodhas,	3	1	1 0	4	2	6	/8/-
389	24	2	82	2,300	Masonry, old,	250/	6/	256/		9/	1/	10/	„	„	„	3 1	Lodhas, Musalman,	3	2	1 5	8	5	12	1/1/-
391	25	2	82	1,244	„ 8 years,	200/	3/	203/		10/	1/	11/	„	„	„ 38', ..	12	Ahirs,	4	.	..	4	3	0	/9/
400	25	2	82	1,091	Masonry, old,	200/	3/	203/		9/	1/	10/-	„	„	„ ..	18	Ahirs,	3			4	2	0	/8/
406	26	2	82	1,450	Kucha unlined,	5/	5/	10/	1/	9/	1/-	11/	„	„	„ 20',	4	Thaggas,	3	1	2·0	4	4	0	/10/
410	26	2	82	1,581	Kucha, lined with wood,	10/	5/	21/		9/	1/	10/	„	„	„ 20',		..	.	1 1 1 1	1 5 1·0 0 75 0·5	4	3 75	0	
412				1,581	Masonry, 4 years,	123/-	5/	130/	..	9/	1/	10/	„	„	„	6	„		1 2	1 0 0 5	4	2 0	0	1 p·3
414				1,593	„ „	175/	5/	180/	..	9/	1/	19/	„	„	„		„	2	1 1	1 0 0 5	4	2 5	0	.

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	Run: Class.	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil.	Command, Kharif 1881-82: Crop	Watering required.	Area.	Total area reduced to one watering	No. of days to area.	Command, Rabi 1881-82: Crop.	Waterings required.	Area.	Total area reduced to one watering	No of days to area.	Area irrigated to date, Kharif 1881-82: Crop	Waterings given.	Area.	Working days to date.	Duty: Per lift.	Duty: Per pair	Area irrigated to date, Rabi 1881-82: Crop	Waterings given.	Area	Working days to date.	Duty: Per lift.	Duty: Per pair
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
369	Kill,	2	1	5 70	27	28	27 5	Dumat,	Cotton,					Barley,	3	06	22	48	Cotton,						Barley,	2	1 06	36	333	166
														Wheat,	4	2 09									Wheat,	3	2 09	17 5	.356	178
														Tobacco,	8	1 15									Tobacco,	2	1 15	8	300	150
														Garden,	7	0 62									Garden,	3	0 62	6	310	155
371	„ 3 p,	2	2	3 71	27	33	30	„	„					Gram,	2	1 34	111	*271	„						Gram,	1	1 34	4	112	056
														Barley,	3	11 4									Barley,	1 54	11 4	38·5	170	085
														Guchana,	4	1 78									Guchana,	1	1 78	4 5	132	066
														Wheat,	4	10 6									Wheat,	1 27	10 6	32	141	070
														Peas,	2	0 5									Peas,	1	0 5	1 5	111	055
														Tobacco,	8	3·0									Tobacco,	1 37	3·0	9	155	·077
381	„	2	1	5 74	14 3	21 7	18	„ II,	„					Peas,	2	1·7	24	132	„						Peas,	1	1·7	5·25	223	162
														Gujai,	4	2 12									Gujai,	3	2 12	14	103	151
														Wheat,	4	2 56									Wheat,	3	2 56	18 5	180	140
														Garden,	7	0 31									Garden,	1	0 31	1	110	155
386	„	2	1	5 31	12 5	19 5	16	„ I,	„					Wheat,	4	0 875	28	81	„						Wheat,	3	0 875	9	192	146
														Garden,	7	3 47									Garden,	3	3·47	30	347	173
389	„	2	2	5 29	23	30	26	„	„					Barley, Peas,	8	5·09	76 5	145	„						Barley, Peas,	2 14	5·00	22 75	240	120
														Wheat,	4	4 81									Wheat,	2 2	4 81	28 0	188	094
														Kurr,	8	5 61									Kurr,	1 24	5 61	16 0	232	116
														Garden,	7	3 03									Garden,	3 58	3·03	23·0	236	118
394	„	2	1	6 525	15	16	15 5	Matyar,	„					Barley,	3	1 57	44	137	„						Barley,	2	1 57	8	392	196
														Barley, Peas,	8	3 357									Barley, Peas,	2	3 357	25	120	135
														Gujai,	4	0 875									Gujai,	2	0·875	5	310	175
														Wheat,	4	5 375									Wheat,	2	5 375	25	430	215
														Garden,	6	0 657									Garden,	3	0 657	3	617	319
400	„	2	1	5·625	15	18	16 5	„	Sugar,	4	2 8	12 4	45	Barley,	3	0·13	30	109	Sugar,	†1	2 8	7	400	200	Barley,	2	0 13	·75	346	178
									Cotton,	1	1 2			Barley, Peas,	3	2 7			Cotton,	1	1 2	3 5	343	171	Barley, Peas,	2	2 7	15 5	348	174
														Guchana,	4	0 956									Guchana,	2	0 956	5	382	191
														Wheat,	4	4·12									Wheat,	2	4 12	22	374	187
														Tobacco,	8	0 2									Tobacco,	1	0 2	·75	266	133
401	„	2	1	5 85	21 2	24	22 6	Sandy,	„					Barley, Peas,	2	0·33	12	150	„						Barley, Peas,	1	0·28	1 5	153	·076
														Gujal,	3	3 0									Gujal,	1 5	3 00	15	·300	150
														Wheat,	4	0 66									Wheat,	3	0 66	12	105	082
410	„	[illegible]	1	5 4	20	21	22	„	Cotton,	1	2 6	2 6	2 0	Barley, Peas,	3	1 12			„	‡1	2 6	2 25	300	150	Barley, Peas,	3	1 12	3	373	186
														Gujai,	3	3 8									Gujai,	2 2	3 8	6	370	185
412	„	[illegible]	1	5 7375	25	26 1	25 7	„						Wheat,	4	15 0	87	61	„						Wheat,	2 26	15·0	81	275	137
														Oats,	4	1 48									Oats,	3	1·43	2 6	408	204
414	„ 2 pur,	2	§1	5 0625	21	24 6	24 3	„						Peas,	2	1 25									Peas,	3	1 25	2 5	·375	187
														Carrots, Kurr,	5	0 20									Carrots, Kurr,	5	0 2	6	400	200
														Tobacco,	8	0·13									Tobacco,	2	0 13	25	260	130
														Garden,	6	0 34									Garden,	1	0·34	25	340	170

* Area small as drinking water was taken from the lifts. † Since rains. ‡ Since rains § 14 feet to-day.

TABLE A.—*Observation and Experiment*—(Continued)

	EXPERIMENTAL																							
	WORK.																	COST						
			Cubic feet lifted			*H P*			*Area Irrigated.*				*Depth*		*Days to an Acre*				*Annual*			*Per Acre*		
Serial Number	Duration of work, minutes.	No. of lifts.	Per pair of cattle per hour	Per lift, per hour.	Total per well.	Per bullock.	Total per well.	Length of watercourse.	Crop.	Watering	Interval.	Area in square feet.	On area.	Of damp	Per pair of cattle.	Per lift.	Per well.	Duty per pair	Interest at 5 p c	Repairs, &c.	Total.	Per acre irrigated	Lifting	Total	Remarks.
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
369	497	429	162	324	2,362	1 153	504	430	Tobacco, .	2	5 days,	20,000	118	60	4 4	2·2	2 2		0·4	13 5	13·9				
374	482	781	91	182	2,921	·780	375 5	670	"	1	·	11,856	216	1·0	14 6	7 34	2 45	·	15·3	15	30 [illegible]				Only 2 lifts working on account of recent rain fall.
381	845	820	164	326	1,871	894	309	300	Garden, ..	1		7,920	230	1 5	11·0	5·5	5·5		1 6	10·0	11·6				
386	465	560	190	892	3,022	970	451	230		4	20 days,	15,000	·20	1 5	5 8	2·9	2 9		14	10	11 6				
389	650	823	100	200	4,354	775	503	500	.	4	30 days,	24,160	18	1·2	7 6	3 8	1 9	·	12 6	10	31 6				
394	403	560	240	480	3,603	·972	450	750	Gujal, .	2	45 days,	15,000	246	75	5 8	2 9	2 9	..	10·1	11·0	21 1				
400	280	809	186	873	1,738	853	230	860	Tobacco,	1	·	12 000	145	1·0	7·2	3·63	3 63	·	10·1	10·0	20 1				
406	632	530	147	295	3,100	904	571	810	Wheat,	3	75 days,	6,916	45	75	12·5	6 3	6 3	·	0·5	11·0	11 5				Field was high and sandy
410		·				..	·	1,420	"	3	75 days,	11,423		75	7·6	3 8	..	..		·	·				
412	673	773	197	395	4,485	1 327	893	230	"	3	75 days,	39,374	·238	·90	4·6	13	70		16·6	30·0	55 6				
414	673	857	228	456	5,110	1 418	954	..	"					·	4 0	2·3	·	..		·					

TABLE A.—*Observation and Experiment*—(Continued)

STATISTICAL.

Serial Number	Province	District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Percentage uncultivated: Waste	Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Cultivated Area: Double cropped area in acres	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Dry	Kharif: Wet: Wells	Kharif: Wet: Canals	Kharif: Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi: Wet: Wells	Rabi: Wet: Canals	Rabi: Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Irrigation Wells: Dry bricks	Irrigation Wells: Kucha	Irrigation Wells: Total	Lifts: Leather bucket	Lifts: Earthen pots	Lifts: Total	Usual labor for lifting buckets	Average area per lift in acres: Kharif	Average area per lift in acres: Rabi	Average area per lift in acres: Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
42.		MEERUT	Serawah,	Karkanda,	1879 80	2676 47	8 2	11 9	79·0	412 6	2549·85	39·0	60·4	12 8	·	007	30 0	43 4	26·8		0·2	29 8	50·6	8 p-3 3 p-16	·		62	85		85	Bullock,	3 85	8 00	11 85	2 pairs of cattle per lift generally used.
4'0			"	"	86 81	2676·47	8 1	12 6	79 8	425 66	2546 86	50·86	49 64	22 2		5	23 8	46·0	27 6		0 6	26 34	54 0	1 p 31	1 p-3	2 p-1 1 p 8		88		88	"	6 42	8 00	14·42	" "
			"	Khukuri,	80 81	726 72	5 6	5 6	89 4	60·22	764 42	15 8	84 2	7 8	·	3	45 5	53 1	8 2			33·7	46·9	" 4 p-8	"	"									
																								8 p-1 2 p-1 1 p-2	··		7	19		19	"	3·00	3 2	6 2	" "
431			Meerut,	Meerut,	79 80	4890·8	21 3	16 3	62 4	1436 6	4188·25	68 1	81 9	18 08	1 4	0 02	28 1	42 6	43·9	4 7	·	8 8	57 4	1 p-265 2 p 8	··	142	415	100	142	242	"	3 37	8 14	11 51	
4 10			"	Mahalla Kiraj,	80 81	4890 8	22 5	12 9	64 6	1408 25	4567·0	61·0	39 0	19 8	1·6		23 8	45 2	36 7	2 9		15 2	54 8	1 p-265 2 p-8	··	142	415	90	142	232	"	8·94	7 22	11 16	
411			Khátaull,	Khátaull,	79 80	2179·0	15 7	9 9	74 4	282 53	1228·62	53 9	46 1	3 4	15 6	0·7	32 6	52 3	54 5	28 7	0·05	13 5	47·7	1 p-7	··	90	97	7	90	97	"	10 99	1 2	2 19	
			"	"	86 81	2179 0	16 6	10 1	73·3	356 3	2167 95	89 8	60 2	3·0	16 5	0 7	28 5	43 7	3 1	16 2	0 3	36·7	56 3	1 p-7	·	90	97	7	90	97	"	0·70	0·8	1 5	
119			Manglaur,	Roorkee,	79 80	1970	50 4	8 4	46 2	275	1145	6 6	93 4	2 5	0·7	·	49·6	52 8	2 4	1 0		48·8	47 2	87	10	25	122	9	9	18	"	1 61	1 56	3 16	
			"	"	80 81	1970	48 8	3·8	47 4	288	1221	5 5	94 5	1 6	0 8		40 5	42 9	3 6	0 5		54 0	57 1	87	10	25	122	9	9	18	"	1 11	1 72	2 88
4.3			Bhurpur,	Nurpur,	79 80	2115 81	8 4	16 1	75 5		1848 2	6 3	93 7	6 0			54 5	60·5	3			89 2	89 5	··	·	55	55	12	43	55	"	2·04	0 10	2 14	
			"	"	80-81	2115 81	9 4	15 6	75 6	119·7	1954 2	5 4	94·6	5 0			47·4	52 4	·4			47 2	47 0		·	51	51	11	40	51	"	1 92	0·16	2 08	
10		BIJ OR	Chándpur,	Pheona,	79 80	1863·0	6·8	6·6	86 6	278 97	1891 75	10·0	90·0	9 8	·		38·8	48 6	0·01		0·2	51 2	51 4	2	·	41	43	89		89	"	4·42	··	4 42	Nearly all sugarcane irrigation
			"	"	80 81	1863·0	6 7	7 8	85 5	191 8	1784 86	4 6	95·4	4 5		··	56 0	61 1	0 10		·	38 8	38·9	2		9	11	11		11	"	9 2	0 21	9 41	

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE.

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well	Class	Cost: Construction	Cost: Fittings	Cost: Total	Cost: Renewal	Cost: Lifts	Cost: Yearly repairs	Cost: Total	Supply	Quality	Substratum	Cultivators on well: Number	Cultivators on well: Caste	Labor and cost per day in annas: Men, home	Do hired	Rate, per day	Cattle	Cost for men	Do. for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
419	26	2	82	615	Masonry, 5 years,	300/	6/	306/	.	8/	1/	17/	Spring, .	Sweet, .	Clay,	1	Mali,	4	2	1 5	8	6	12	1/2/-
																3	Chamars,							
425	27	2	82	1,073	" old,	300/	6/	306/	.	8/	1/	17/	" .	"	" 27',	9	Thaggas, .	4	2	1 3	8	6-3	12	1/2/3
430	27	2	82	85	" 40 years' old	400/	10/	410/		8/	1/	25/	" ..	"	" 45',	12	"	7	3	1 5	1-	10-5	18	1/12,6
																1	Brahmin,							
431	28	2	82	71	" old,	300/	6/	306/	..	8/	1/	17/	"	"	" 40,	1	Pathan, ..		3	2-0	4	6	6	/13/3
	1	3	82												"		"		1	1 25		1 25		
	1	3	82												" .		"	-	1	2-0	1	3	6	/9/-
439	28	2	82	48	"	150/	3/	153/	.	9/	1/	10/	"	" .	"	1	Pathan,	2	1	2-0	4	3	6	/9/-
																1	Mali,							
																1	Kurmi,							
																1	Beral,							
444	8	3	82	1,374	" .	100/	4/	101/		8/	1/	9'	"	" ..	" 26',	10	Thaggas,	6		..	8	4	12	1/
																1	Mali,							
417	8	3	82	835	"	100/	4/	104/		8/	1/	9/	" .	"	"	x	Thaggas, .	4			4	3	6	-/9/-
449	6	3	82	681	Kucha lined, ..	14/	2/6	16/6	2/	6/	1/	7/	"	" .	" 30,	1	Mali,	1		2 0	2	4	3	/7/
451	6	3	82	680	Masonry, .	100/	3/	103/	.	6/	1/	7/	"	" .	" .	1	" .	1	2	2-0	4	1	6	/10/
453	17	3	82	828	Kucha lined,	3/	2/	5/	17/	4/	1/	6/	Percolation,	"	Sand,	1	Musalman, .	3			2	2	3	-/5/
455				803	" "	3/	2/	5/	1/	4/	1/	6/	" ..	" .	"			3	.		-	2	3	/[illegible]/
457				761	" "	3/	2/	5/	1/	4/	1/	6/	" ..	"	" .	2	Jats,	3	.		2	2	3	-/[illegible]/
459				760	" " .	3/	2/	5/	1/	4/	1/	6/	"	"	" .	2	" .	3		..	2	-	3	/5/
460				2,515	" "	5/	1/	6/	1/	1/	1/	3/	" .	" .	"	1	Kachi, ..	2		.	.	1		/1/
463	.			2,523	" "	5/	1/	6/	1/	1/	1/	9/	"	"	" .	1	Mali,	2				1	.	/1/
465	18	3	82	198A	" "	10/	1/	11/	1/	4/	1/	6/	Spring, .	"	Clay 13', .	x	Chamar,	6	.		8	5	12	1/1/
467				198B	" "	10/	1/	11/	1/	1/	1/	6/	"	" .	"		" .	4	2	1-0	8	5	12	1/1/-
469				180	" "	10/	1/	11/	1/	4/	1/	6/	"	"	"		"	5	.		8	5	12	1/1/-
471	10	3	82	5,703	" "	5/	2/	7/	1/	3/	1/	5/	" .	" .	" 15', .	6	Musalmen,	3	.		4	-	6	-/8/-
472				5,744	" "	5/	2/	7/	1/	3/	1/	5/	"	"	" .	1	"	3			4	3	6	/8/

TABLE A —*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL — COMMAND. Run: Class.	Run: Pairs of cattle to each lift	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil	Kharif 1881 82: Crop	Kharif 1881 82: Waterings required	Kharif 1881 82: Area.	Kharif 1881 82: Total area reduced to one watering	Kharif 1881 82: No of days to area.	Rabi 1881 82: Crop	Rabi 1881 82: Waterings required	Rabi 1881 82: Area.	Rabi 1881 82: Total area reduced to one watering	Rabi 1881 82: No of days to area.	AREA IRRIGATED TO DATE — Kharif 1881 82: Crop	Kharif 1881 82: Waterings given	Kharif 1881 82: Area.	Kharif 1881 82: Working days to date.	Kharif 1881 82 Duty: Per lift.	Kharif 1881 82 Duty: Per pair	Rabi 1881 82: Crop	Rabi 1881 82: Waterings given.	Rabi 1881 82: Area.	Rabi 1881 82: Working days to date.	Rabi 1881 82 Duty: Per lift.	Rabi 1881 82 Duty: Per pair
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	88	84	85	86	87	88	89	90	91
														Barley,	8	0 47									Barley,	2	0 47	1	·470	235
														Wheat,	4	11 8									Wheat,	2	11 3	47	240	120
419	Kill, 2 pur,	2	2		20			Dumat,	Cotton,					Oats,	4	0 23	61·5	128	Cotton,						Oats,	2	0·28	5	·460	·230
														Carrots,	6	0 84									Carrots,	6	0 34	3 0	340	840
														Garden,	6	2 00									Garden,	5 3	2 00	12 0	442	221
														Barley, Peas,	8	7 2									Barley, Peas,	2 55	7 2	40	280	115
425	" "	2	2	5 23	20·5	27 5	24	Sandy,	Sugar,	8	7·75	64	128	Peas,	8	0 875	61	122	Sugar,	5	7 75	80	242	121	Peas,	2	0·875	4	218	109
								Dumat,	Cotton,	1	2·0			Wheat,	4	9 25			Cotton,		2 0				Wheat,	2	9·25	44	210	105
														Gram,	1	0 7									Gram,		0 7			
														Barley,	8	2 63									Barley,	3	2 62	18	146	·073
430	" "	2	3	5 34	22	28	25	Sandy, Matyar,	"					Guchana,	4	9 00	102	102	"						Guchana,	1	9 00	18	167	083
														Wheat,	4	14·48									Wheat,	1 5	14 43	32	218	109
431	" "	2	1	5 0	20 5 20·5	28 33 5	24 25 27	Matyar,	"					"	3	7 22	21 66	37	"						Wheat,	2	7 22	11	656	328
	" "	2	1	4·05			27	"	"					Potatoes,	10	2 7	27 00	15	"						Potatoes,	4	2 70	8	675	337
														Garden,	10	1 28	12 80	22							Garden,	2	1 28	2	640	320
														Barley,	2	3 91	7 82								Barley,	1	3 91	6*	651	825
439	" "	2	1	6·64	18	19 4	13 7	"	"					Wheat,	3	5 20	15 60	75	"						Wheat,	1	5 20	15*	846	173
														Potatoes,	10	1 31	13 1	89·3							Potatoes,	1	1·31	2†	650	825
414	" "	4	1	4 5	12	18 8	15 4	Dumat,	Sugar, '82 83	5	12 4	63	130	"					Sugar, '82 83	0 22	12·4	8	342	033	"					
447	" "	2	1		13			"	" "	5	8 5	16 5	49 5	Wheat,	4	3 58	14·12	42	" "		8 5				Wheat,	4	3 58	42	386	718
449	Lagor,	1	1	2 36	13	20	16 5	"	"					Garden,	10	2 4	24·0	69	" "						Garden,	5	2 4	30	400	400
451	"	2	1	3 4875	11	26	18 5	"	"					"	10	3·4	3 4	68	" "						"	4	3·4	20	680	340
453	Kill,	1	1		17			Matyar,	"	3	1 9	5 7	27	"					"	3	1 9	27	211	211	"					
455	"	1	1		16			"	"	3	1 28	3 84	24	"					"	3	1 28	24	160	160	"					
457	"	1	1		15			"	"	3	1 34	4 62	27	"					"	2	0·6	8	150	150	"					
459	"	1	1		15			"	"	3	1 25	3·75	18	"					"	3	1 25	18	200	210	"					
460	Dhenkli,		1	0 253	19	21	20	"	"					"	10	1 25	12 5	37 5	"						"	x	1 25	6	210	
463	"		1	0 20	19	21	20	"	"																					
465	Kill,	4	1	2 76	15	18	16 5	Dumat,	" '82 83	3				"	10	0·25	2 5	31	"						"	x	0 25	3 0	081	
											8·7	26·0	29	"					" '82 83	1	1 21	2 5	242	060	"					
467	"	4	1	3 18	17	20	18 5	"	" "	3																				
469	"	4	1	3 7125	15	17	16	"	" "	3	4 25	12 75	41	"					" "	1	2 18	6 5	335	·084	"					
471	"	2	1	2 82	17	19	18	"	"					Wheat,	1	12 0	12 0	44	"						Wheat,	1	12 0	44	272	186
473	"	2	1	3 44	17	19	18	"	"					"	1	1 7	1 7	5	"						"	1	1 7	5	340	170

* Incorrectly stated, area seems low, accepted correct.

† Field in ridges.

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL. WORK. Duration of work, minutes.	No. of lifts.	Cubic feet lifted. Per pair of cattle, per hour	Per lift, per hour.	Total per well.	H P Per bullock	Total per well	Length of watercourse	Area Irrigated. Crop	Watering	Interval.	Area in square feet.	Depth. On area.	Of damp	Days to an Acre. Per pair of cattle.	Per lift.	Per well.	Duty per pair	COST. Annual. Interest at 5 p. c.	Repairs, &c.	Total.	Per Acre. Per acre irrigated	Lifting	Total.	Remarks.
	92	93	94	95	96	97	98	99	100	101	102	108	104	105	106	107	108	109	110	111	112	118	114	115	116
419			.	.					Rabi, .	"	.	22,000			8·0	4 0	2·0		15 8	17·0	32 8				
425	630	1,264	157	315	6,010	1 111	700	1,020	Wheat,	3	60 days,	22,000	30	90	8·0	4 0	2·0	..	15·8	17·0	32 8				
430	616	’090	180	301	11,160	1 300	800 {	1,130	Barley,	8	60 days,	28,532	25	90	} 6·0	8·0	1·0		20·5	25 0	45 5				
								2,030	Guchana,	2	90 days,	10,268	25	70											
434	550	542	150	800	2,710	1·070	587	870	Wheat,	2	60 days,	10,880	25	·75	6 84	3·42	1·71	{							Only 1 lift working
	510	572	159	818	2,800	1 378	744	550	"	2	90 days	14,000	·20	66					15 3	171	32 8				
	535	705	170	840	3,037	1·482	798	640	Potatoes,	4	60 days,	38,577	08	75	2 26	1,18	0·56								Field in ridges
439	598	577	193	380	3,831	·946	563	1,020	Wheat,	2	60 days,	4,907	1	06	7 4	3·7	3 7	}	7 0	10	17 0				
	653	633	193	386	4,208	947	619	1,020	" .	2		18,557	31	·66	6 4	3 2	3 2								
444	700	1,358	180	522	6,111	680	440	800	Sugar,	1	.	20,770	29	1 0	8 4	2 1	2 1		5 2	9·0	14 2				
447								"	Wheat,	4	80 days,	14,630			6 0	3·0	3·0	.	5 2	9·0	14·2				
449	495	640	183	183	1,510	·970	480	500	Potatoes,	3	20 days,	15,175	·10	80	2·87	2 57	2·87		0 8	7·0	7·8				Field in ridges.
451	540	587	114	228	2,047	·770	415	175	Garden, .	3	8 days,	21,134	10	80	4 0	2·0	2 0		5 1	7 0	12 1				" "
453									Sugar,	3	.	6,200	.	.	5·0	5 0	5 00		0 3	0 0	6·8				
455		.		.		.			"	3	.	7,000	..		6 2	6 2	6 2		0·3	0 0	0 3				
457						.			"	2	.	6,500			7·0	7 0	7 0		0 3	0·0	6·3				
459								.	"	3		9,000			5 0	5 0	5·0	.	0·3	6 0	6 3				
460	520	1,888		40	850	1 or man 400	205	100	Garden,	"	.	6,453	·054	80		7·0	7·0	.	0·8	3·0	3·3				Part ridges
463	220	569		81	114	Per man 300	66	60	"	"		3,400	·038	60		12·6	12 6		0 3	3 0	3 3				½ day's work.
465	787	1,381	78	313	3,819	362	207	660	Sugar, .	1		17,578	22	75	9·6	2·4	2·4	.	0 5	6·0	6 5				Palco.
467	775	1,441	100	400	5 015	592	380	1 380	"	1		22,208	220	66	8·0	2·0	2 0		0 5	6·0	6·5				"
469	795	1,260	88	353	4,078	·382	303	2,030	"	1		13,531	·34	·75	12·8	3 2	3 2		0·5	6 0	6 5				"
									Wheat,	1	.	11,848			7 3	3 7	3 7		0·4	5 0	5 0				"
									"	1		14,800			6·0	3·0	3·0		0 4	5 0	5·0				"

TABLE A —*Observation and Experiment*—(Continued)

STATISTICAL.

Serial Number	Province	District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Percentage uncultivated: Waste	Percentage uncultivated: Culturable	Cultivated Area: Percentage of actual area cultivated	Cultivated Area: Double cropped area in acres	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Percentage of Total Cultivated Area: Dry	Kharif, Wet: Wells	Kharif, Wet: Canals	Kharif, Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi, Wet: Wells	Rabi, Wet: Canals	Rabi, Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Irrigation Wells: Dry bricks	Irrigation Wells: Kacha	Irrigation Wells: Total	Lifts: Leather bucket	Lifts: Earthen pots	Lifts: Total	Usual labor for lifting buckets	Average area per lift, in acres: Kharif	Average area per lift, in acres: Rabi	Average area per lift, in acres: Total	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
480		Moradabad	Chandpur,	Rajubpur,	1879 80	1060	0 5	11 1	82 4	1·08	858	4 3	95 7	3 0	..		51 7	54 7	1 3			44·0	45 8	..	..	83	88	.	88	88	Bullock,	0·77	2 24	3 01	
			"	"	80 81	1060	6 4	11 2	82 4	6 0	863 65	4 6	95 4	3·8			47 0	51 4	0·8			47 8	48 6			61	61		01	61	"	0·51	0 80	1 31	
481			"	Burhanpur,	79 80	358	11 4	17 2	71 4	2 8	258 65	1 8	98 7	1 8			64 4	65 7				34 8	34·3		..	8	8	.	0	6	"	0 54		0 54	
			"	"	80-81	358	11 4	15 7	72·9	10 85	271 94	0·4	99 6	0 4	.		61 2	61 6	.			38 4	38 4	.	..	1	1	..	2	2	"	0 5		0·5	
488			Rampur,	Lohah,																			..	.	.	..				.					Native State
490		Bareilly	Kiror,	Nekpur,	79 80	851 0	30 5	16·2	53 3	103 5	558 65	20·6	79·4	5 0	.	0 5	51 0	56·5	7 5	.	7 0	28·4	48 5	8	12	47	67	11	50	67	"	0 42	0 62	1·04	Wells examined are in Mukranapur
492			"	"	80-81	854 0	29·0	15 6	55 4	23 10	685·4	9 5	90 5	4·0		0·3	50 0	54 2	5 3		.	40 5	45 8	8	10	68	96	11	85	96	"	0·30	0 40	0·70	
497			Nawábganj,	Nawábganj,	79 80	888 35	9 4	11 6	79 0	102 7	804 75	21 2	78 8	5 13		0·7	46 8	52 0	7 9	0 3	7 8	32 0	48·0		..	35	35		35	35	"	1 20	1·80	3·00	
499			"	"	80 81	888 35	8 8	10 5	80 7	121 7	838 2	5·5	94 5	4 9	..	2·0	56 7	61 8	0 8	0 1	.	37 8	38 2		.	24	24		24	24	"	1 70	0 12	1 82	
501		Pilibhit	Púranpur,	Puránpur,	79-80	1508 0	9 5	16 0	74 5	168 15	1200 9	3 1	90 9	2 9			42 9	45 8	0 2			54 0	54 2		.	88	88		70	70	"	0·52	05	0 57	Nearly all sugarcane.
503			"	"	80-81	1508·0	9 3	15 2	75 5	36 7	1175 2	2 8	97·2	2 7			58·3	61·0	0 1			88 9	89·0		..	44	44	.	70	70	"	0·50	·01	0 51	" " "
506			Pawáyan,	Dhurmangatpur,	79 80	267 2	8·8	23 1	68 1	81 62	213 37	34·6	65 4	4 9			80 6	35 5	21·0		8·7	34 8	64 5	1	.	8	9	9	.	9	Men,	1 18	5·0	6 18	W S has fallen 5' to 6' (1882-83)
507			"	"	80-81	267 2	8·9	21 5	69 6	29 75	215 60	8 9	91 1	8 2	.	0·3	48 3	50 8			0·4	42 8	48 2	1	.	2	8	8		8	"	5 98	.	5·98	
514		Shahjahanpur	Sháhjahánpur,	Sháhjahánpur,	79-80	3088·0	48 1	11 1	40 5		1249 8	62 9	87 1	81·7		0 0	18·5	50·8	18 4		17 2	18·0	49 2	1 p-27	.	1 p 50 Dhenkli 10 Ráti 77	164	77	87	164	Men and Bullock,	3·06	1·01	4·07	W. S. has fallen 3' (1882-83)
516			"	,	80 81	3100 5	18 3	10 2	11·5	378 7	1667 0	66 1	33·9	23 5		3·5	20·0	47 0	18 1		26·0	13·9	53·0	1 p-27	..	1 p 50 Dhenkli 15 Ráti 106	288	77	211	288	"	1 40	0·8	2 2	
520			Jalálabad,	Jalálabad,	79 80	716 0	25 3	17 7	57·0	46·0	453·3	28 5	71 5	1·8			38 7	40 5	13 4	.	14 8	32·8	59 5		.	Dhenkli 65 Ráti 12	77		77	77	"	0 11	0·74	0·85	W. S. rises 6' with Ramganga floods.
521			"	"	80-81	710·0	25 7	15 9	58·0	50 75	474 45	41 1	58·9	3·4	.		38 4	41 8	24 5		13·2	20 5	58 2	.	.	Dhenkli 95 Ráti 14	100		100	100	"	0 15	1·06	1 21	

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE.

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well	*Class*	*Cost*: Construction	Fittings	Total	Renewal	Lifts	Yearly repairs	Total	*Supply*	*Quality*	*Substratum*	*Cultivators on well*: Number	Caste	*Labor and cost per day in annas*: Men, home	Do hired	Rate, per day	Cattle	Cost for men	Do for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
					.					.	.	..	..		..	1	Mali,	8	4	2·0	8	10	12	1/6/-
476	20	8	82	4,550	Kucha lined,	0 5	2/	8 5	2/	5/	1/	8/	Spring,	Sweet,	Clay, 20',	1	Musalman,	1	2	1 5	2	3	8	/6/-
478	20	3	82	4,398	„ unlined,	4/	2/	6/	2/	4/	1/	7/	„	„	„ 17',	7	Malis,	3			4	2	6	/8/-
480	21	3	82		„ lined,	1 5	0 5	2/	1·5	1/	.	2 5	„	„	Sand,	1	Jat,	1	2	1 5		3		-/3/-
484	24	3	82	101	„ „	2 5	1/	3 5	2/	1/	.	4/	„	„	„	8	Chamars,	3				2	.	/2/
488	27	3	82		„ „	5/	1/	6/	2/	1/	.	3/	„	„	„	2	Kachis,	2				1		/1/
490	30	3	82	40 40	Masonry, „ „	250/ 250/ 250/	3/ 3/ 3/	750/	..	10/	1/	38/	„	„	Clay,	12 12	„ „ „	2 1 3	1 2	2 0 2 0	2 2 2	3 4 2	3 3 3	/18/ /5/
494	30	3	82	30	„	250/	3/	253/-	.	8/	1/-	9/	„	„	„	1	„	1	2	2·0	2	4	3	/7/-
497	31	3	82		Kucha lined,	2/	1/	3/-		1/	1/-	2/	„	„	„	1	„	2	.	.		1	.	-/1/
501	3	4	82	201	„ unlined,	5	1/	1 5	0 5	1/	.	1 5	Percolation,	„	Sand,	1 1	Pathan, Carpenter,	.	4	2		3		/8/-
505	7	4	82	112	„ lined,	2/	2/	4/	2/	4/	..	6/	Spring,	„	Clay, 20',	1 2	Pasi, Brahmin,	3	5	1 25		3 25		/8/3
508	7	4	82	220	Masonry,	100/	3/	103/	..	4/	1/-	5/	„	„	„ „	5 1 1 2 1	Chamars, Barber, Carpenter, Blacksmiths, Jat,	5	3	1·25	.	7 75		/7/0
514	8	4	82	600	„	180/	2/	182/	..	10/	1/-	11/	„	„	„ 42',	1	Kachi,	1	1	1 5	2	1 5	3	/5/0
517	9	4	82	100	„ wood below,	150/	2/	152/		10/	2/	12/	„	„	„ 24',	2 1	Pathans, Kachi,		1 3	1 25 1 5	2	1·25 4·5	3	/7/6
520	10	4	82		Kucha lined,	2/	0 5	2 5	0·5	1/	0 5	2/	Percolation,	„	Sand,	1	„	2	.	.		1		/1/-
522	11	4	82	266/1	„ unlined, very old,		1/	1/	.	1/		1/	Spring,	„	Clay, 20',	x	Kachis,	2				1		/1/-

TABLE A.—*Observation and Experiment*—(Continued).

EXPERIMENTAL.

Serial Number	Run: Class.	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil.
	62	63	64	65	66	67	68	69
	Same well, .	2	2	.		..		Dumat,
476	Kili, .	1	1	4 5	17	19	18	„
478	„	2	1	4 0	19	21	20	„
490	Dhenkli,		2	230625 30375	9 5 9 5	10·5 10 5	10 10	Sandy,
484	„		2	27562·5	18 6	19·0	18 8	,
488	Rati,		2	310	21	22	21 5	Dumat,
490	Kili,	1	1	5 625	36	39	37 5	
	„	1	1	4 3875	35	42	38 5	„
	„ .	1	1	5 34	35	42	38 5	
404	„ .	1	1	4 05	34	42	38	„
497	Rati,	.	2	0 4	9	10	9·5	Matyar,
501	Dhenkli, .		2	0 4	14	17	15 5	Sandy, .
505	Coolie,	Men 6	1	1 63	29	31	30	Dumat,
508	„	Men 6	1	.	22	29	25·5	„
514	Lagor,	1	1	4 05	30	34	32	„
517	„	1	1	4 00	32	35	33 5	„
520	Dhenkli,		1	0 4	12	14	13	Matyar,
522	Rati,		2	0·4	24	25	24 5	„

COMMAND

Serial Number	Kharif 1881-82: Crop.	Waterings required.	Area	Total area reduced to one watering	No. of days to area.	Rabi 1881-82: Crop	Waterings required	Area.	Total area reduced to one watering	No. of days to area.
	70	71	72	73	74	75	76	77	78	79
	Sugar, '82-83,	4	1 41	5·64	15	Wheat,	.	.	.	.
476	„					Tobacco,	80	1 0	30 0	87
478	Indian corn,	#	9375			„ .	80	9375	28 125	91
490	Sugar, '82-83,	4	90	2 8	16	„			.	..
484	„ „	4	1·00	4 0	44	„ .				..
488	„					„	28	0·15	4·2	76
490						Garden,	28	0 07	2 0	
	„		.			Tobacco,	20	9·4	198	198
404	„			.		Wheat, . Tobacco, .	2 10	0 625 1 5	81 25	219
497	„		.			Garden,	10	0·5	5 0	55
501	„ '82 83,	3	2·8	5 6	30	„			.	.
505	„ „	2	2·44	4 88	29 28	Wheat,	1	4·5	4 5	13
508	„ „	2	7 56	15 12	128	„	1	13·3	18 8	44 5
514	„		..		.	Tobacco, Barley,	20 2	1 72 0 56	35·5	110
517	„					Tobacco, .	20	2 3	40	193
520	„			.		Garden,	20	0·625	12 5	187
522	„					„ .	20	1 10	23 2	394

AREA IRRIGATED TO DATE

Serial Number	Kharif 1881-82: Crop	Waterings given.	Area.	Working days to date.	Duty: Per lift.	Duty: Per pair	Rabi 1881-82: Crop	Waterings given	Area	Working days to date.	Duty: Per lift.	Duty: Per pair
	80	81	82	83	84	85	86	87	88	89	90	91
	Sugar, '82 83	1	1 41	8	235	117	Wheat, .		.		..	
476	„	..					Tobacco,	6	1 00	20	300	300
478	Indian corn,	#	9375				„ .	6	9375	10	562	231
490	Sugar, '82 88	1	7	4	0·097		„	.	.		..	.
484	„ .		.	.			„ .		..	.		..
488	„	.		.	.		„	16	0 15	82	075	
490							Garden, .	16	0·07	16	075	
	„ .	.		.	..		Tobacco,	10	9 4	140	180	180
404	„	..	.	.	.		Wheat, Tobacco,	2 12	0·625 1 50	10 103	125 166	125 166
497	„				.		Garden,	.	0 5			.
501	„ '82-83	1	2 8	1 5	0 000	..	„ .		.		..	..
505	„ „	1	0·842	6	0 140		Wheat,	1	4 5	13	346	.
508	„	1	7 56	81 5	0·240		„	1	13·3	44 5	·800	..
514	„				.		Tobacco, . Barley,	10 2	1 72 0 56	80 2	570 560	570 560
517	„					..	Tobacco,	4	2 8	30	306	306
520	„			.			Garden,	#	0·625	4	181	.
522	„		.		.		„	#	1 10	..	087	

TABLE A — *Observation and Experiment*—(Continued)

EXPERIMENTAL.

Serial Number	Work: Duration of work, minutes	Work: No of lifts	Work: Cubic feet lifted: Per pair of cattle, per hour	Work: Cubic feet lifted: Per lift, per hour	Work: Cubic feet lifted: Total per well	Work: H P: Per bullock	Work: H P: Total per well	Work: Length of watercourse	Work: Area Irrigated: Crop	Work: Area Irrigated: Waterings	Work: Area Irrigated: Interval	Work: Area Irrigated: Area in square feet	Work: Depth: On area	Work: Depth: Of damp	Work: Days to an Acre: Per pair of cattle	Work: Days to an Acre: Per lift	Work: Days to an Acre: Per well	Work: Day's per pair	Cost: Annual: Interest at 5 p c	Cost: Annual: Repairs, &c	Cost: Annual: Total	Cost: Per Acre: Per acre irrigated	Cost: Per Acre: Lifting	Cost: Per Acre: Total	Remarks
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
	646	741	96	100	2,096	481	812	600	Sugar,	1		16,05[illegible]	2[illegible]	75	10.6	5.4	5.4								
	588	600	10	210	2,004	518	301		"	1					10.8	5.1	5.1								
470	247	219	240	240	985	1,144	28	270	Tobacco,	6	3 days,	15,340	.464	.6	2.3	2.9	2.3		0.4	6.4	6.4				
478	268	200	112	220	1,01[illegible]	[illegible]	16[illegible]	230	"	6	4 days,	13,26[illegible]	.076	.70	6.[illegible]	3.25	3.2[illegible]	..	0.3	7.0	7.[illegible]				
480	621 / 625	2,663 / 3,062		63 / 86	660 / 930	Per man 371	232	160	Sugar,	1		7,600	29	.56		11.0	5.6	.	0.1	2.[illegible]	24				
481	570	5,001		62	1,37[illegible]	Per man 56[illegible]	[illegible]	300	" .	1		4,000	316	1.2		[illegible]0	11.0	.	0.[illegible]	4.0	4.[illegible]				
488	27	66[illegible]	.	60	270	Per man 615	168	100	Tobacco, .	16	6 days,	3,540	.05	.6[illegible]	..		1.5	.	0.[illegible]	34	3.[illegible]				Bits taken as lift.
490	530	351	244	244	1,974	2,206	1,160	1,130	"	10	7 days,	14,[illegible]	13	.5[illegible]	3	3	3								
	573	461	210	210	2,045	2,305	1,300	600	"			14,770	11	.5[illegible]	3	3	2.2		55.0	23	71.0				
	8[illegible]	16[illegible]	280	280	8[illegible]0	3,064	667	470	"			6,17[illegible]	17	7.[illegible]	8	8	.								
491	28[illegible]	175	148	148	70[illegible]	1,600	473	[illegible]	" .	12	7 days	6,05[illegible]	11.[illegible]	7.[illegible]	7	7	7	.	12.[illegible]	9.[illegible]	21.[illegible]				½ day a week
497	180	631		61	[illegible]2	Per man 33[illegible]	70	160	Palco,	.	.	3,0[illegible]	.05	.6	11	11	11		0.[illegible]	2[illegible]	2				" "
501	678	1,057		1[illegible]	423	Per man 100	60	23[illegible]	Sugar,	1		5,0[illegible]7	.6[illegible]	7[illegible]	.	10.5	[illegible]4		0.1	1.[illegible]	14				Hired labor.
50[illegible]	69[illegible]	1,211		174	1,071	Per man 487	[illegible]	900	"	1		7,[illegible]	274	1.4	.	6	6		0.[illegible]	6.0	6.[illegible]				
508		..			.			600	"	1		5,100		.		6.5	6.5	.	5.1	5.0	10.1				Measured area.
514	563	490	200	200	1,931	1,864	1,0[illegible]	[illegible]00	Tobacco,	10	6 days,	1,[illegible]	12	[illegible]	[illegible]	3.[illegible]	[illegible]	.	[illegible]	11.[illegible]	[illegible]0.1				
517	532	435	197	197	1,75[illegible]	1,814	[illegible]	[illegible]31	" .	10	10 days,	10,170	17.[illegible]	8[illegible]	4.2	4.2	4.2	.	7.[illegible]	12.[illegible]	12.[illegible]				
520	438	900		48	360	Per man 320	140	120	Garden, ..		4 days	3,760	[illegible]	[illegible]	.	11	11	.	0.1	2.[illegible]	2.1				Bits [illegible]
522	401	961		60	38[illegible]	Per man 140	[illegible]	140	" .			2,[illegible]31	11	.40	.	17	17		0.0	1.0	1.0				1 day's work.

TABLE A —*Observation and Experiment*—(Continued)

STATISTICAL

1	2	D. 3	Locality: Pergunna. 4	Locality: Village. 5	Year 6	Area in Acres: Actual area in acres. 7	Area in Acres: Percentage uncultivated: Waste. 8	Area in Acres: Percentage uncultivated: Culturable. 9	Cultivated Area: Percentage of actual area cultivated 10	Cultivated Area: Double cropped area in acres. 11	Cultivated Area: Total area actually cultivated in the year 12	Percentage of Total Cultivated Area: Wet. 13	Dry 14	Kharif: Wet: Wells. 15	Kharif: Wet: Canals. 16	Kharif: Wet: Other sources. 17	Kharif: Dry 18	Kharif: Total. 19	Rabi: Wet: Wells. 20	Rabi: Wet: Canals. 21	Rabi: Wet: Other sources 22	Rabi: Dry 23	Rabi: Total 24	Irrigation Wells: Lime masonry 25	Irrigation Wells: Dry bricks. 26	Irrigation Wells: Kucha. 27	Irrigation Wells: Total 28	Lifts: Leather bucket. 29	Lifts: Earthen pots. 30	Lifts: Total. 31	Usual labor for lifting buckets. 32	Average area per lift in acres: Kharif 33	Average area per lift in acres: Rabi. 34	Average area per lift in acres: Total. 35	Remarks. 36
28	N. W. P.	CAWNPORE	Bithor, .	Bithor,	1879 80	2398 0	11 0	16 4	69·6	286·5	1955	18 0	82 0	0·5		0·4	40·0	40 0	8 1	.	0 0	42·0	50 1	1 p-3 2 p 3	1 p 10	1 p-51	67	70		70	Bullock,	0 11	2 27	2 38	
30			" .	"	80 81	2398·0	11 8	15 7	70·0	148 3	1822	26 0	73 1	0 8		0 4	41 1	42 3	11·2	.	14 5	32·0	57·7	1 p-3 2 p 3	1 p-10	1 p-46	62	65		65	"	0 20	3 15	3 35	In '81 82 many wells failed
30	OUDH	UNAO	Unao,	Unao,	79 80	4597 0	21 2	30 9	47 9	361 5	2563 5	73·4	26 6		.	38 0	17 1	55 1	19·9	.	15 5	9·5	44·9	82	.	125	207	215		215	"		2 37	2 87	
			" .	"	80-81	4597 0	21 2	40 9	37 9	72·0	1813	63 6	36·4	4 3		29 9	36 4	70·6	29 4			.	29 4	82	..	136	218	225		225	"	0 85	2 37	2 72	
12			Mona, .	Duryaganj,	79-80	672 5	30·6	33 4	36 0	6 75	248 25	93 7	1 3		.	23·7	0·7	24 4	3·0	.	72·0	0·0	75·6	3	1	10	14	.	5	5	Men,	.	1 5	1 5	
			"	"	80-81	672 5	28 8	32 5	38 7	5·05	265·55	21 5	75 5		.	3 5	5·4	8 9	3 9	..	17 1	*70 1	91 1	3	1	30	34	..	5	5	"	..	2 06	2 06	* Crop failed.
52		LUCKNOW	Lucknow, ..	Banthra,	79 80 80 81	1192 8	35 0	11 0	54 0	21 1	665·1	26·9	73 1	0 4			55·1	58·5	22 4		4 5	14 6	41 5	1	..	26	27	20	6	26	Bullock and Men,	0·11	5·78	5 84	
68			"	Hamirpur, .	79 80																														
					80-81	631 0	31 1	17 1	51·2	21	316 7	23 2	76 8	2 2	.	0·6	63 0	64 8	10·6	.	9·8	14 8	85 2	1	..	3	4	1	3	4	Men and Cattle,	1 94	9 14	11 08	
72			Mallhabad, ..	Mallhabad,	79 80	1611 5	20·0	30·2	49 8	16	849·35	44 1	55 6	1 8		0·3	38 7	40·8	37 7	0·4	4 2	10 9	59·2	42	15	20	86	69	.	69		0 23	4 64	4·87	

TABLE A —*Observation and Experiment*—(Continued)

DESCRIPTIVE

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well	*Class*	*Cost*: Construction	Fittings	Total	Renewal	Lifts	Yearly repairs	Total	*Supply*	*Quality*	*Substratum*	*Cultivators on well*: Number	Caste	*Labor and cost per day in annas*: Men, home	Do, hired	Rate, per day	Cattle	Cost for men	Do for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
534				266/3	Kucha unlined, very old,		1/	1/		1/	..	1/	Spring,	Sweet,	Clay,		Kachi,	2	1	5		1 5	.	-/1/6
526				262	" "		1/	1/		1/		1/	"	"	"		"							
528	16	4	82	853	Kucha lined with wood,	..	.		.	.	.	..	"	"	" 75',	2 1	" Herdsman,	2	1	2·0	2	3	3	/6/
533	16	4	82	850	" "			.	.				"	"	"	1 1	Kachi, Kurmi,	3		.	2	2	3	-/5/-
535	20	12	81		Masonry,	150/	3/-	153/	.	5/	1/	6/	"	"	" 48',	1	Pathan,		3	1 5	2	4·6	3·0	-/7/6
537 539					Kucha, "	6/ 6/	21/ 4/	10/ 10/	.	4/ 4/	2/ 2/	10/ 6/	" "	" "	" "	2 1	Lodhas, Musalman,	3		.	4	2	6	-/8/
540					"	6/	4/	10/	.	4/	2/	6/	Percolation,	"	"	1	Kachi,	3			4	2	6	/8/
542	21	12	81		"	2/	1/	3/	1/	1/	.	2/	"	"	Sand,	1	Mahajun,	2	2	2·0		5		/5/-
545					"	2/	1/	3/-	1/	1/	.	2/	"	"	"	2	Kachis,	4				3		/3/
549					"	2/	1/	3/	1/	1/		2/	"	"	"	1	Lodha,	3		.		2		/2/
552	22			.	Kucha unlined, 10 years' old,	5/	3/	8/	..	4/	1/	5/	Spring,	"	Clay,	1	Brahmin,	3		.	3	2	4 5	-/6/6
555	23	12	81		Masonry, old,	150/	3/	153/	.	4/	1/	5/	"	"	"	10	Chamars,	8				7		/7/
559	23	12	81		Kucha lined,	3/	2/	5/	3/	4/		7/	"	"	"	x	Kachis,	3			4	2	6	-/8/
563	23	12	81		" "	3/	2/-	5/	3/	4/	..	7/	"	"	"	x	"	8				7	..	/7/
566					" "	3/	2/	5/	3/	4/		7/	"	"	"	3	"	5				4		-/4/
568	23	12	81	.	Masonry, old,	150/	3/	153/-	.	4/	1/	5/	"	"	"	7	Thakurs	.	10	1 4		14		/14/-
572	8	1	82		Dry brick,	27/	3/	30/		5/	1/	6/	Percolation,	"	Sand,	1	Pathan,	1	2		2	3	3	/6/-

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number	Run: Class	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil	Experimental, Command, Kharif 1881 82: Crop.	Waterings required	Area.	Total area reduced to one watering	No of days to area.	Experimental, Command, Rabi 1881 82: Crop	Waterings required	Area	Total area reduced to one watering	No of days to area.	Area Irrigated to Date, Kharif 1881-82: Crop	Waterings given.	Area.	Working days to date.	Duty: Per lift.	Duty: Per pair	Area Irrigated to Date, Rabi 1881 82: Crop	Waterings given	Area.	Working days to date.	Duty: Per lift.	Duty: Per pair
62	63	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
521	Râtl,		4	0.4	23	25	24	Matyar,	Sugar,					Garden,	20	2 82	46.4	269	Sugar,						Garden,	x	2 82		·087	
528	Lagor,	1	1	2.64	47	50	48.5	Damat,	"					Potatoes,	12	0.5	40	224	"						Potatoes,	12	0.5	24	0 250	0 250
														Tobacco,	12	1 0									Tobacco,	12	1.0	60	0 200	0 200
														Garden,	10	1 6									Garden,	8	1 6	56	0·228	0 228
														Wheat,	4	1.5									Wheat,	4	1 5	24	0·250	0 250
533	"	1	1	2 59	48	57	62 5	"	"					Tobacco,	12	1 7	40.8	216	"						Tobacco,	10	1 7	65	261	261
														Potatoes,	12	1 7									Wheat,	12	1 7	78	261	261
535	"	1	1		35	41	38	"	"					Wheat,	4	1 27	50 8	127	"						"	0 5	1 27	10	063	063
537	"	1	2		31			"	"					"	4	2 934	11 78	67	"						"	1	2.0	11 5	·087	087
539	"	1	1		29	36	32.5	"	"					"	4	1 891	7 56	105	"						"					
540	"	1	1		28	36	32	"	"					"	4	3·083	12 83	172	"						"	1	1 0	14	·071	·071
542	"	Men 2	1			20		Matyar,	"					"	8	0 70	2·1	45	"						"	1	0·7	12	·060	
545	"		1			20		"	"					"	4	270	14	266	"						"	1	274			
														Opium,	10	548									Opium,	1	548			
														Garden,	15	500									Garden,	x	500			
549	"		1			20		"	"					Wheat,	4	0 3	8.2	80	"						Wheat,	1	0 3	15	033	
														Opium,	10	0 2									Opium,	1	0 2			
552	"	1 5	1	2·025	20	24	22	Damat,	"		1 8			Wheat,	3	3 76	11 28	146	"						Wheat,	1	3 76	27	140	073
555	"	Men 6	1	1 4625		30		"	"					Barley,	2	2 125	30	81	"						Barley,	1	5·625	18	812	
														Wheat,	2	9 90									Wheat,					
														Opium,	10	0 625									Opium,					
559	"	2	1			21 5		" Matyar,	"					Barley,	2	1 3	48	116	"						Barley,	1	6 25	17	367	188
														Wheat,	2	7 15									Wheat,					
														Opium, Garden,	5	5·2									Opium, Garden,					
563	"	Men 7	1			25		"	"					Barley,	2	4.0	16 0	74	"						Barley,	1	4·0	37	216	
														Wheat,	2	4.0									Wheat,	1	4 0			
564	"		1			21		Damat,	"					Opium,	5	1 54	7 7	70	"						Opium,	1	0 66	6	110	
568	"		1	2 5875	17	17	17	Matyar Dumat,	"					Barley,	2	5 28	4 8	89	"						Barley,	1	3·00	40	·254	
														Wheat,	3	9 00									Wheat,	1	7 00			
														Opium,	5	2 10									Opium,	1	1 58			
572	"	1	1		30	40	35	Matyar,	"					Wheat,	3	2 5	7 5	68	"						Wheat,	1	2 5	27	·092	·092

TABLE A.—*Observation and Experiment*—(Continued)

EXPERIMENTAL.

Serial Number	WORK: Duration of work, minutes.	WORK: No. of lifts.	Cubic feet lifted: Per pair of cattle, per hour	Cubic feet lifted: Per lift, per hour.	Cubic feet lifted: Total per well.	H P: Per bullock.	H P: Total per well	Length of watercourse	Area Irrigated: Crop	Area Irrigated: Watering	Area Irrigated: Interval.	Area Irrigated: Area in square feet.	Depth: On area.	Depth: Of damp	Days to an Acre: Per pair of cattle.	Days to an Acre: Per lift.	Days to an Acre: Per well.	Duty per pair	COST: Annual: Interest at 5 p. c.	COST: Annual: Repairs, &c.	COST: Annual: Total.	COST: Per Acre: Per acre irrigated.	COST: Per Acre: Lifting	COST: Per Acre: Total.	Remarks.
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
524	400	2,200	..	60	905	Per man 785	814	150	Garden,	.	.	7,500	12	70	.	11·5	11·5		0·1	2·0	2·1				2 wells together.
528	527	384	115	115	1,014	1,507	820	270	{ Tobacco, { Garden,	12 8	12 days, .	7,550	·13	·75	50	5·6	5·6	.	..		.				Area double cropped.
533	530	450	130	133	1,181	2,005	1,110	160	Tobacco, .	10	12 days,	8,165	14	70	5·3	5·3	5·3	..	.	.	.				" " "
535	.			.	.	.		.	Wheat,	1	.	1,720	.		25	25	25	.	5·1	6·0	11·1				Water short
537	.	..			..	..	..	..	" ,	1		7,000	..	.	11·4	11·4	5·7	..	0·5	10·0	10·5				
539 540	.. .	. .	.	.		.	. .	800 420 }	" ,	1	..	6,000	..	.	14	14	14	.	1·0	12·0	13·0				
542	.	..	..	.	.	..		{ 500 { 150	" .. "	1 1	.	1,400 3,140		. .	.. ..	30 13	30 } 13 }		0·2	2·0	2·2				
545	480			..		..	..	300	Opium,	1		2,250		..	.	10	10	..	0·2	2·0	2·2				
549 552	 630	 501	. 80	. 118	 1,107	 495	 812	200 400	{ Wheat, { Opium, Wheat, .	1 1 } 1	 .	1,702 5,000	. 239	.. .	. 13·0	25 8·7	25 8·7	.	0·2 0·4	2·0 5·0	2·2 5·4				
555	600	1,262	..	108	1,845	Per man 472	811	1,300	" .	1	..	10,000	·115	.	..	2·7	2·7		7·0	5·0	12·0				
559		..	..	.	..		.	a	" .	1	.	10,000	..	..	5·4	2·7	2·7	.	0·3	7·0	7·3				
563 566	..	.	 ..	.. .	. .	.	.	a }	Barley, Wheat, . Opium,	1 1 } 1	 .	9,408 4,850	.. .	. .	.. ..	4·0 9	4·0 9	..	0·3 0·3	7·0 7·0	7·3 7·3				
568	750	1,020	.	397	4,008	Per man ·440	330	700	Wheat,	1	..	24,000	·211	.	.	1·81	1·81	.	7·0	5·0	12·0				
572	.							330	" .	1	.	4,754	.		9	9	9		1·5	6·0	7·5				

TABLE A'—*Observation and Experiment*—(Continued)

STATISTICAL.

	Locality: Province	Locality: District	Locality: Pergunna	Locality: Village	Year	Area in Acres: Actual area in acres	Area in Acres: Percentage unculti vated: Waste	Area in Acres: Percentage unculti vated: Culturable	Cultivated Area: Percentage of actual area cultivated	Cultivated Area: Double cropped area in acres	Cultivated Area: Total area actually cultivated in the year	Percentage of Total Cultivated Area: Wet	Percentage of Total Cultivated Area: Dry	Kharif: Wet: Wells	Kharif: Wet: Canals	Kharif: Wet: Other sources	Kharif: Dry	Kharif: Total	Rabi: Wet: Wells	Rabi: Wet: Canals	Rabi: Wet: Other sources	Rabi: Dry	Rabi: Total	Irrigation Wells: Lime masonry	Irrigation Wells: Dry bricks	Irrigation Wells: Kacha	Irrigation Wells: Total	Lifts: Leather bucket	Lifts: Earthen pots	Lifts: Total	Usual labor for lifting buckets	Average area per lift, in acres: Kharif	Average area per lift, in acres: Rabi	Average area per lift, in acres: Total	Remarks
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	OUDH	LUCKNOW	Malihabad,	Malihabad,	1880 81																														
8			"	Rahimganj,	79-80	1717 0	12 0	6·3	81 7	20 0	170 0	41 7	58 3	3·5			49 5	53·0	37 0		0·8	8 8	47·0	7		25	32	300		30	Men, Cattle,	0·19	2 1	2·29	Number of lifts doubtful.
9			"	"	80 81																														
8		HARDUI	Sandilla,	Sandilla,	79 80																														
					80 81																														
5			"	Gousganj,	79 80																														
					80-81																														
2			Bilgram,	Ansanpur,	79 80	253 5																													Area subject to Ganges flood.
			"	"	80-81	253 5	4 8	11·0	83 0	10 1	221 8	8 2	91 8				83·2	83 2	8 2			58·6	66 8			11	11		11	11			1 66	1 66	

TABLE A.—*Observation and Experiment*—(Continued)

DESCRIPTIVE

Serial Number	Date: Day	Date: Month	Date: Year	Number of Well.	Class	Cost: Construction.	Cost: Fittings.	Cost: Total.	Cost: Renewal.	Cost: Lifts.	Cost: Yearly repairs.	Cost: Total.	Supply	Quality	Substratum.	Cultivators on well: Number	Cultivators on well: Caste	Labor and cost per day in annas: Men, home.	Do. hired	Rate, per day	Cattle.	Cost for men	Do. for cattle	Total cost, per day
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
574	3	1	82		Dry brick, .	27/-	3/	30/		5/	1/-	6/	Spring, .	Sweet, .	Clay,	1	Kachi, ..	4			4	3	6	-/9/-
578	4	1	82		" " .	27/	3/	30/		5/	1/	6/	" .	" .	"	3	Ahirs, .	2	1	1 5	4	2 5	6	-/8/6
581	4	1	82	.	" " .	27/	3/	30/-	.	5/	1/	6/	"	"	"	7 1	" Brahmin,	8				7		-/7/-
584	4	1	82		Kucha,	6/-	3/	9/	2/	5/-	1/	8/	"	" .	"	1	"	3			4	2	6	/8/-
586	4	1	82		"	6/	3/	9/	2/	5/	1/	8/	" .	" .	"	1	"	3			3	2	4 5	/6/
588	5	1	82	.	Masonry, .	150/	3/	153/	.	4/	1/-	5/	"	" .	"	1	Musalman, .	2	1	1 5	6	3·5	9	/12/6
590					Dry brick,	20/	3/			.			"	"	" .	1	"		3	1 5		13 5		/13/6
591				.	Kucha, .	5/	3/	31/	2/-	4/	2/	12/	"	"	"		" .		3	1 5	4	4 5	6	-/10/6
593	6	1	82	..	" lined, .	1/	0 5	1 5	1/	1/		2/	Percolation,	" .	Sand,	1 1	Kachi, Brahmin,	2		.		1	.	/1/-
596					3 " " .	2/	1/	3/	2/	1/		4/	"	"	"	8	Kurmis, .	3				3	..	/2/-
598				.	2 " " .	2/	1/	3/-	2/-	1/		4/	"	" .	" .		"	3	..			2		/2/-
600					7 " "	7/	3/-	10/-	7/-	1/	.	14/-	"	"	" .	.	" .	8				7		/7/-
602	7	1	82		2 " " .	2/	1/	3/-	2/-	5		3/	" .	"	"	2	Kachis, .	3		..		2		-/2/-
605					1 " "	1/	0 5	1 5	1/-	0 5	.	1 5	"	"	" .	1	" ..	2		.		1		-/1/-
608	8				3 " " .	2/	2/	4/	2/	2/-		4/	"	"	"	2 2	Brahmins, . Lohars,	2 2				1 1		-/1/- /1/-

TABLE A.—*Observation and Experiment*—(Continued)

Serial Number	EXPERIMENTAL. Run: Class	Run: Pairs of cattle to each lift.	Lift: Number	Lift: Content in cubic feet.	Depth to Wells: Morning	Depth to Wells: Evening	Depth to Wells: Mean.	Soil	COMMAND. Kharif 1881-82. Crop.	Kharif 1881-82. Waterings required.	Kharif 1881-82. Area.	Kharif 1881-82. Total area reduced to one watering	Kharif 1881-82. No. of days to area.	Rabi 1881-82. Crop	Rabi 1881-82. Waterings required	Rabi 1881-82. Area.	Rabi 1881-82. Total area reduced to one watering	Rabi 1881-82. No. of days to area.	AREA IRRIGATED TO DATE. Kharif 1881-82. Crop	Kharif 1881-82. Waterings given.	Kharif 1881-82. Area.	Kharif 1881-82. Working days to date.	Kharif 1881-82. Duty: Per lift.	Kharif 1881-82. Duty: Per pair	Rabi 1881-82. Crop	Rabi 1881-82. Waterings given	Rabi 1881-82. Area	Rabi 1881-82. Working days to date.	Rabi 1881-82. Duty: Per lift.	Rabi 1881-82. Duty: Per pair
	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
574	Lagor,	2	1		30	40	35	Matyar,	Sugarcane,	8	1·06	8·48	40	Wheat, Opium, Potatoes,	3 6 9	2 25 0 46 0·7	16	75	Sugar,	x	1 06	5	213	106	Wheat, Opium, Potatoes,	x x x	2 25 0 46 0·7	16	213	106
578	,,	2	1	2 25	29	34	31 5	,,	,,	12	0·51	6 12		Wheat, Opium,	3 6	4 8 0·18	14	88	,,	x	0·51	3 5	146	073	Wheat, Opium,	x x	4 8 0·18	80	146	073
581	,,	Men 6	1	1 5	26	35	30 5	Dumat,	,,					Rabi,					,,						Rabi,				·333	
584	,,	2	1	2 07	27	31	29	,,	,,					,,					,,						,,				147	·071
586	,,	1 5	1	1 068	27	34	30 5	,,	,,					,,					,,						,,				091	·060
588	,,	3	1	2 59	20	30	25	Matyar,	,,	8	2 0	16 0		Wheat,	2	5·3	10 6	58	,,	x	2 0	10	200	67	Wheat,	1	5 3	26 5	200	067
590	,,	Men 7	1	2 25	22	38	30	,,	,,					,,	2	7 0	14 0	104	,,						,,	1	7 0	52	134	
591	,,	2	1		23	30	25	,,	,,					Garden,	5	1 4	7 0	175	,,						Garden,	x	1·4	35	040	·026
593	Râti,		2		16	16	16	Dumat,	,,					Wheat,	2	2·8	5 6	56	,,						Wheat,	1	1 87	17	110	
596	,,		4		16	16	16	,,	,,					,,	2	1 56	3 12	30	,,						,,	1	1 56	15	052	
598	,,		4		16	16	16	,,	,,					,,	2	1 1	2 2	34	,,						,,	1	1 1	17	·032	
600	,,		14					,,	,,					,,	2	7 65	15 3	46	,,						,,	1	7 65	23	·042	
602	Dhenklis,	..	2	0 436	10	10	10	Mutyar,	,,					,, Opium,	3 5	3 5	14·0	140	,,						,, Opium,	1	3 5	20	·017	
605	,,	..	1	0·394	9	10	9 5	,,	,,					Barley, Opium,	2 5	1 25 1 125	3 12	114	,,						Barley, Opium,	1	1 125	16	070	
608	Râti, 2 Dhenklis,		2 2	0·314 0 394	10	10	10	Dumat, ,,	,, ,,					Wheat, Opium,	2	4 16	8 33	141	,,						Wheat, Opium,	x	416	35	060	

TABLE A.—*Observation and Experiment*—(Continued)

	Experimental.																								
	Work.																		Cost						
			Cubic feet lifted			*H P*			*Area Irrigated*				*Depth*		*Days to an Acre.*				*Annual*			*Per Acre*			
Serial Number	Duration of work minutes.	No. of lifts.	Per pair of cattle, per hour	Per lift, per hour	Total per well.	Per bullock.	Total per well.	Length of watercourse.	Crop.	Watering	Interval.	Area in square feet.	On area.	Of damp	Per pair of cattle	Per lift.	Per well.	Duty per pair	Interest at 5 p. c.	Repairs, &c.	Total.	Per acre irrigated	Lifting	Total	Remarks.
	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
574									Wheat,	1	30 days	9,278			9 4	4·7	4·7		1 5	6·0	7 5				
									Opium,	2	15 days,														
									Potatoes,	3	10 days,														
578	540	505	63	126	1,186	584	315	1,120	Wheat,	2	30 days,	7,290	1558		12	6·0	6·0		1 5	6·0	7 5				
581	540	881	..	140	1,321	Per man 468	264	690	Peas,	2		13,500	10			3 2	3·2		1 5	6·0	7 5				Supply short.
584	570	501	55	110	1,037	·470	265	580	Wheat,	2		6,250	17		14·0	7·0	7·0		0 5	8·0	8 5				
586	570	488	33	50	468	331	189	420	"	1		3,850	1475		16 5	11	11		0·5	8·0	8 5				
588	520	501	50	150	1,298	394	207	510	"	2	30 days,	8,425	154		15	5	5		7 6	5 0	12 6				
590	550	658		160	1,470	Per man ·477	262	505	"	1		5,866	25			7 4	7 4		1 6	12·0	13 6				
591									Garden	"		1,660			50	25	25								
593									Wheat,	1	..	4,420				10	10		0·1	2·0	2 1				
596									"	1		2,250				20	20		0·2	4 0	4 2				
598	..								"	1		1,376				31	31		0·2	4 0	4 2				
600									"	1	..	2,000				21	21		0 5	14·0	14 5				
602	390	1,242		83	541	Per man ·400	150	180	Opium,	1		4,055	235			20	20		0·2	3·0	3 2				
		996		67	484	308	120																		
605	390	1,076		65	424	Per man ·300	114	150	Opium,	1		3,077	138			14	14		0 1	1·5	1·6				
608	630	1,721		51	540	238	153	120	Wheat	1		2,500	20			17	17								
	630	1,267	..	47	498	219	138	500	Opium,	1		4,100	12			10	10		0·2	4·0	4·2				

TABLE B.

District.		Number	Depth to water surface	No of lifts.	No of cattle or men lifting	Class.	Rabi: Duty per Well.	Rabi: Duty per Lift.	Rabi: Duty per Pair	Kharif: Duty per Well	Kharif: Duty per Lift.	Kharif: Duty per Pair	Rabi: Wheat.	Rabi: Wheat & Barley	Rabi: Wheat & Gram	Rabi: Barley	Rabi: Barley & Gram	Rabi: Barley & Peas.
Cawnpore,	..	533	52	1	2	Lagor,	3 40	3 40	3 40	.	.	.	.	..		.	..	.
,,		528	48	1	2	,,	4 60	4 60	4 60	..	..		1 50 4	.	..		..	..
,,		2	42	2	5	,,	3 50	1 75	1 40	3 20	1 60	1 33		3 50 3	..	..	..	..
,,		3	38	1	2	,,	3 30	3 30	3 30	1 60	1 60	1 60	3 30 3	..	..	..	..	..
,,		5	38	1	2	,,	2 65	2 65	2 65	1 85	1 85	1 85	2 65 3	..	.	.	..	..
,,		11	37	2	4	,,	*1 00	0 50	0 50	.	.		1 00 3	..		..	..	.
,,		37	37	2	4	,,	3 50	1 75	1 75	..	.		3 50 3	..	..	.	..	..
,,		9	36	2	4	,,	3 77	1 88	1 88		.	.	.	2 45 2	.	..	..	..
,,		13	35	3	6	,,	8 58	2 86	2 86	.		.	2 23 3	..	..	..		3 45 2
,,		8	32	2	4	,,	3 85	1 92	1 92	..	..	..	3 85 4	.	.	..	..	..
,,		16	29	1	3	,,	3 10	3 10	2 06	.	..	..	..	3 10 2	.	..	..	..
,		21	20	2	4	,,	6 10	3 05	3 05	2 0	1 0	1 0	..	6 10 3	..	..	.	..
,,		22	20	2	4	,,	6 10	3 05	3 05	2 0	1 0	1 0	.	6 10 3	..	..	..	..
,,		20	16	1	2	,,	1 50	1 50	1 50	..		.	1 50 2	.			..	..
Mean,	..	.	34	..	3 4	,,	4 15	2 68	2 57	2 13	1 41	1 35	35 5 3	38 7 3	.	..	.	6 3 2
Hamirpur,	..	59	113	1	2	,,	*0 15	0 15	0 15			.	.	..	..	..	.	..
,,		60	111	2	4	,,	*0 24	0 12	0 12		.	.		..	.	.	..	.
,,		58	88	2	4	,,	*0 32	0 16	0 16		..				.	..	.	..
,,		61	57	1	2	,,		.		2 27	2 27	2 27	..		.	..		
,,		45	45	3	6	,,	3 Wells. 9 90	3 30	3 30	.	..	.		.	..	.	.	
,,		47	45	1	2	,,	3 40	3 40	3 40	.							.	..
,,		54	42	7	14	,,	4 Wells 37 00	5 28	5 28					..	.	..		..
,,		37	41	1	4	,,	*0 90	0 90	0 45	1 73	1 73	0 86	.	..	..			..
,,		36	38	1	2	,,	2 10	2 10	2 10	.		.	..		..	..	..	.
,,		50	38	6	12	,,	4 Wells. 14 00	2 33	2 33		.	.	.	.	.	.	..	
,		40	37	1	2	,,	1 30	1 30	1 30	.	.	.		..			.	.
,,		26	36	2	4	,,	4 56	2 28	2 28			.	.		.	..	..	.
,,		38	36	1	2	,,	3 50	3 50	3 50		.	.	..	..		.	..	.
,,		24	35	1	4	,,	2 00	2 00	1 00	.			..	..	..			

* These examples are omitted in the calculations for mean areas, &c.

Provinces and Oudh, and the number of waterings required for each class of irrigated crop—1881–83

Rabi												Kharif					
Safflower	Safflower & Gram	Safflower & Carrots.	Gram	Carrots	Peas	Oats	Opium.	Tobacco	Potatoes.	Garlic.	Garden	Sugar	Cotton	Indian Corn	Millet.	Indigo	Remarks.
								1 70	1 70								Area
..	..	..	..	..			..	12	12			..	..	.	..	..	Waterings
								1 00	1 00		1 60						Area
.	..	..	..	..				12	?2		10		.		..		Waterings
													3 20				Area
..	..	.	.	..		.	..	.	..	..		.	2			..	Waterings
													1 60				Area
..	..		.	..				.	..		..	.	2				Waterings
													1 85				Area
..		..		..		.	.	..	.	..	.	.	2	.		.	Waterings
																	Area
..	.	..	..	..	.		..		.	.	..	.				..	Waterings
																	Area.
.	..	..	.		.			.	.	.	..		..	.	..	.	Waterings
							1 32										Area
.		..		..	.		6	..	.	.		.	.		..		Waterings
							2 90										Area
..	.	.	..	.	..	.	6	..				..	..	.	.	..	Waterings
																	Area
..		..	..	.	.		..	.	.	.		..		..			Waterings
																	Area
.	.	..	.	.		..	..	..	.				.		..	..	Waterings
													2 00				Area
.		..	..	.	..	.		..	..	..		.	2	.	.		Waterings
																2 00	Area
		.		.	..		.			.	.	.	.			2	Waterings
																	Area.
..		..			.	..	..				.	.	.				Waterings
							7 7	4 9	4 0		2 9		81 2			18 8	Per cent area
..	..	.			..		6	12	12		10	.	2	..	..	2	Mean waterings Area 65 60
							0 15										Area
.	..		..	.	.		10	.	.	..	..	.	.		.	.	Waterings
							0 24										Area
.	.	.	.	.	..		10	.			..		.	.		.	Waterings
							0 32										Area
.				.	..	..	7	.		.	.		.	.			Waterings
												2·27					Area
..		.	..	.	.	.	.	.	.	.		4	..		..		Waterings
								9 9									Area
.	..		.		..			5	.	..	..	.	.				Waterings
								3 4									Area
.	..	.	.	.	.	.	.	5	.	..	..	.	.			.	Waterings
								37 0									Area.
.	.	.			..	.		7	.	.	.	.	.		.	.	Waterings
											0 9	1 73					Area.
.	..	-		..	.	..	.	..	..		10	4				.	Waterings
							2 1										Area
		.		.	..	..	10	.	..	.			.			..	Waterings
								14 0									Area
.		..	..	..		..	..	7	.	..		.	..		..	..	Waterings
											1 3						Area.
..	.	..	..	.	.	.		..	..	.	10	.	..	.	..	..	Waterings
							4 56										Area
.			.	.	.		5			..	.	..	.		..	.	Waterings
								3 50									Area
	..	..		.			.	10							..		Waterings
							2 0										Area.
	..	.	.	..	..	.	5	.	..		.	.	..		.	..	Waterings

District.	Number	Depth to water surface	No of lifts	No of cattle or men lifting	Class.	Rabi Duty per Well	Rabi Duty per Lift.	Rabi Duty per Pair	Kharif Duty per Well	Kharif Duty per Lift.	Kharif Duty per Pair	Rabi Wheat	Rabi Wheat & Barley	Rabi Wheat & Gram	Rabi Barley	Rabi Barley & Gram	Rabi Barley & Peas
Hamirpur—(*Contd*)	32	27	2	1	Lagor,	4 00	2 00	2 00	..	..		..	.	.		.	
,,	31	22	1	4	,,	2 83	2 83	1 41		.	..	..	.	..	.	.	..
,,	29	22	1	2	,,	2 60	2 60	2 60	2 60	2 60	2 60	..		.	.		
,,	27	21	1	2	,,	*0 90	0 90	0 90	..	..	..	.	..	.	..	..	
,,	35	19	1	2	,,	1 70	1 70	1 70	..		..	.	..	.	4 7 6	.	..
,,	48	18	2	4	,,	.		.	3 00	1 50	1 50	.	..	..	..		..
,,	49	18	2	8	,,	.	.	.	1 75	0 82	0 41	.	.			.	.
,,	42	16	2	1	,,	2 60	1 30	1 30	..			..	.	.	2 6 6		
,,	41	14	2	4	,,	3 40	1 70	1 70	1 80	0 90	0 90		.	.	3 4 5		.
,,	43	14	2	4	,,	3 60	1 80	1 80	..	.	..	..	3 6 3			.	..
,,	34	12	1	2	,,	2 00	2 00	2 00	.	..	.	..		..	2 0 6	..	
Mean, .	Kharif, Rabi,	28 33	.	4 3	} ,,	1 32	2 61	2 50	2 19	1 64	1 12	..	3 4 3	.	12 0 6	.	
Farukhabad,	67	66	7	14	,,	6 Wells 35 90	5 13	5 13		.	..	5 60 2	.	..	30 30 1		..
,,	63	58	2	4	,,	8 50	4 25	4 25	..	--		1 23 3		.	7 23 2		.
,,	90	58	1	2	,,	3 26	3 26	3 26	1 63	1 63	1 63	..	.	.	.		..
,,	66	57	1	2	,,	2 11	2 11	2 11	.		.	.	2 11 3		.	.	..
,,	88	56	1	2	,,	3 46	3 46	3 46	1 73	1 73	1 73	.	.		.	.	
,,	72	47	1	2	,,	3 92	3 92	3 92			.	.		..	2 66 2		
,,	69	46	2	5	,,	2 Wells 7 73	3 86	3 09		..		4 26 3	..	..	1 43 2	.	
,,	92	36	1	2	,,	2 58	2 58	2 58	1 29	1 29	1 29			..			..
,,	74	35	1	2	,,	3 15	3 15	3 15				0 66 4	0 86 3		1 26 2		.
,,	84	35	1	2	,,	1 20	1 20	1 20				0 90 4					..
,,	94	35	1	2	,,	2 34	2 34	2 34	1 17	1 17	1 17		.	.	.	..	
,,	78	32	1	2	,,	2 69	2 69	2 69		.		1 09 4	1 60 3		.	.	
,,	80	32	1	2	,,	3 07	3 07	3 07			.	1 26 4	0 57 3		0 94 2	.	..
,,	87	16	1	1	Dhenkli,	0 60	0 60	1 20	.	..		.	.				
,,	86	15	1	1	,,	0 60	0 60	1 20			.					..	
Mean, ..	Lagor,	K 46 R. 51		2 2	Lagor,	4 21	3 15	3 10	1 45	1 45	1 45	18 7 4	6 4 3		53 7 2	.	.
,,	Dhenkli,	16	..	1	Dhenkli,	0 60	0 60	1 20	.								

* These examples are omitted in the calculations for mean areas, &c.

Provinces and Oudh, and the number of waterings required for each class of irrigated crop—1881-83—(Continued)

Rabi												Kharif					
Safflower	Safflower & Gram	Safflower & Carrots	Gram	Carrots	Peas	Oats	Opium	Tobacco	Potatoes	Garlic	Garden	Sugar	Cotton	Indian Corn	Millet	Indigo	Remarks
								4 00									Area
..	.	..	.	..	..	..	..	10	..	..		.	..	.		.	Waterings
								2 83									Area
	..	..	..	..	..	..	.	7	.	..	..	..	..		..		Waterings
											2 6		2 60				Area
..	..		..	..	.	.		.	..	..	10	..	2		..	..	Waterings
											0 9						Area
..	..	.	..	.	..		.	..		..	10	.				.	Waterings
																	Area
.	.	..	..	..	.	..		..	..		..	.	..			..	Waterings
												3 00					Area
..	.	..	..	.	.	.		..			..	7	..			.	Waterings
												1 75					Area
..	..	..	..	..	.	..	..	..	..	..	..	8	.	.	.		Waterings
																	Area
.		.	..	..	.		..	.	..					.		.	Waterings
												1 8					Area
..	.	.	..	.	..		.		..			8	.	..	..	.	Waterings
																	Area.
	.	.	..		..	.					.	..		.	.	..	Waterings
																	Area
..	..	.			.	.	..	.	.	.	..	..	..	.	..	..	Waterings
							8 8	70 5			5 3	80 2	19 8				Per cent area
..	..	..	..	.			8	6		.	10	6	2		..		Mean waterings Area 119 15
																	Area
..	..		..	.		..		..		.	..	.			..	.	Waterings
							0 40										Area
..				.		.	6		.	.	..	.	.			..	Waterings
								1 63	1 63					1 63			Area
.		..	.	.	..	..		10	10	.	-	.	..	2			Waterings
																	Area.
..	..	.	.				..	..		..		..	..	.		.	Waterings
								1 73	1 73					1 50	0 23		Area.
..		..			..	..		12	12					2	2	..	Waterings
							1 26										Area
.	..	..	..	.	.	.	7	.				.		..	..	.	Waterings
							2 06										Area
..	..	..	..				6			.		.	..	..	..	..	Waterings
								1 29	1 29						1 29		Area
..	..	..					.	10	10	..		..	..	..	4		Waterings
							0 37										Area.
..	..	..	..	.	.	..	12	.		.	.	.	.	..	.	..	Waterings
							0 30										Area
.	.	.					12		.	.	..	..	..	.	..	.	Waterings
								1 17	1 17					1 17			Area
.	.					.		10	10	.	..		.	2	..	..	Waterings
																	Area.
..	..	.		.		.	..	..	..	..	.	.	.	..	..	..	Waterings
							0 30										Area
..	..	.	..	.	..	.	12	.	..	.	.	.	..	..	..	.	Waterings
											0 60						Area
	.	..	..			..	.	.	..	.	12	.	..	..	..		Waterings
											0 60						Area
..		.	..		.	..	..		..	..	12	..	.	..	.		Waterings
							5 8	7 2	7 2		1 0			73 8	26 2		Per cent. area
..	..	..	..	.	..	..	8	10	10	..	12	..	..	2	3	.	Mean waterings Area 86 11
..	..	..	..	..	..	.	..	..	..		..	.	.	.	..	..	

District.	Number	Depth to water surface.	No of lifts.	No of cattle or men lifting	Class.	Rabi Duty per Well.	Rabi Duty per Lift.	Rabi Duty per Pair	Kharif Duty per Well	Kharif Duty per Lift.	Kharif Duty per Pair	Rabi Wheat.	Rabi Wheat & Barley	Rabi Wheat & Gram	Rabi Barley	Rabi Barley & Gram	Rabi Barley & Peas.
Etah—(*Contd*)	192	19	2	4	Lagor,	6 40	3 20	3 20				1 30 4			4 00 3		
,,	195	18	1	4	Kılı,	*1 60	1 60	0 80				1 60 4					
,,	178	14	3	6	Lagor,	2 Wells 4 70	1 57	1 57	1 70	0 57		2 70 4			2 00 3		
,,	180	12	2	4	,,	6 86	3 43	3 43				6 00 4			0 66 3		
,,	183	12	2	4	,,	6 90	3 45	3 45				2 30 4	1 26 3		1 80 2		
Mean,		16		4	,,	5 92	3 20	2 50	1 70	0 57	0 57	56 0 4	3 0 3		31 5 3		
Alıgarh,	255	45	2	4	Kılı,	7 98	3 99	3 99				3 52 4			3 46 3		
,,	251	39	1	4	,,	5 62	5 62	2 81				3 63 4			1 43 3		
,,	248	38	1	2	,,	8 80	8 80	8 80				3 90 5			4 90 4		
,,	279	35	1	4	,,	7 40	7 40	3 70				2 23 4			0 23 3		
,,	275	33	2	4	,,	16 73	8 36	8 36				5 20 3					11 30 3
,,	259	29	7	28	,,	42 16	6 02	3 01				27 20 3	2 65 3		1 03 2		9 94 2
,,	242	28	1	4	,,	6 34	6 34	3 17				2 71 5					
,,	239	27	1	2	,,	1 95	1 95	1 95				0 83 5			1 12 4		
,,	283	27	1	4	,,	8 04	8 04	4 02				2 30 4			2 14 8		3 60 3
,,	268	23	4	8	,,	22 99	5 75	5 75				9 90 3	3 40 3		4 50 2		
,,	225	20	3	x	,,	22 86	7 27					13 57 5			7 43 3		
,,	229	20	2	6	,,	2 Wells 17 14	8 57	5 71	3 17	1 58	1 06	7 86 5			7 17 3		
,,	234	19	3	6	,,	14 79	4 93	4 93				7 34 5			5 03 3		
,,	207	18	1	6	,,	9 91	9 91	3 30	3 57	3 57	1 19	3 50 4			5 54 3		
,,	221	17	1	4	,,	16 37	16 37	8 09				11 34 3			4 91 2		
,,	211	16	2	6	,,	9 05	4 52	3 02	2 43	1 22	0 81	2 03 4	1 71 3		3 83 3		
,,	217	16	2	12	,,	22 45	11 22	3 74				10 90 3			8 75 2		
,,	203	14	1	4	,,	8 52	8 52	4 26				4 98 3	1 43 2				
,,	200	11	2	8	,,	9 43	4 71	2 36				8 70 4			0 73 3		
Mean,	Kharif, Rabi,	18 24 7		6	,,	12 92	7 28	4 50	3 02	2 12	1 02	50 3 4 to 5	3 5 3		24 0 3		9 6 3
Muttra,	307	67	2	8	,,	13 52	6 76	3 38				7 81 4			5 71 2		
,,	300	62	2	4	Lagor,	7 01	3 50	3 50				5 71 4			0 73 3		

* These examples are omitted in the calculations for mean areas, &c.

Provinces and Oudh, and the number of waterings required for each class of irrigated crop—1881-83—(Continued)

Rabi												Kharif					
Safflower	Safflower & Gram	Safflower & Carrots	Gram	Carrots	Peas	Oats	Opium	Tobacco	Potatoes	Garlic	Garden	Sugar	Cotton	Indian Corn	Millet	Indigo	Remarks
				1 10													Area.
				8													Waterings
																	Area
																	Waterings
												1 70					Area
												3					Waterings
							0 20										Area
							10										Waterings
				0 54			1 00										Area
				10			8										Waterings
				4 0		0 5	3 0					100 0					Per cent area
				9		6	9					3					Mean waterings Area 43 18
											1 00						Area
											4						Waterings
		0 66															Area
		4															Waterings
																	Area
																	Waterings
				4 94													Area.
				5													Waterings
	0 23																Area
	1														...		Waterings
		1 34															Area
		5															Waterings
		0 83						0 80	1 10	1 00							Area
		3						6	4	10							Waterings
																	Area
																	Waterings
																	Area
																	Waterings
		1 26						3 03			0 90						Area
		5						10			10						Waterings
					1 86												Area
					2												Waterings
0 60					1 51								3 17				Area
3					2								2				Waterings
			1 14					1 28									Area
			1					10									Waterings
							0 30	0 57					3 57				Area.
							10	10					2				Waterings
						0 12											Area.
						6											Waterings
							0 20	1 28					2 43				Area
							10	10					2				Waterings
			2 80														Area.
			1														Waterings
			2 11														Area
			1														Waterings
																	Area
																	Waterings
0 4	0 1	1 6	2 0	2 0	1 4	0 05	0 2	2 7	0 6	0 55	1 00		100 0				Per cent area.
3	1	4	1	5	2	6	10	10	4	10	7		2				Mean waterings Area 267 80
																	Area.
																	Waterings
		0 57															Area
		5															Waterings

TABLE B—*Showing the Yearly Area in Acres commanded by Wells in 20 Districts of the North-Western*

District	Number	Depth to water surface	No of lifts	No of cattle or men lifting	Class.	RABI. Duty per Well.	RABI. Duty per Lift.	RABI. Duty per Pair	KHARIF Duty per Well	KHARIF Duty per Lift.	KHARIF Duty per Pair	RABI. Wheat.	RABI. Wheat & Barley	RABI. Wheat & Gram	RABI. Barley	RABI. Barley & Gram	RABI. Barley & Peas.
Muttra—(*Contd*),	319	59	2	4	Kih,	9 17	4 58	4 58		..		4 72 5			2 73 3		1 06 3
,,	325	59	2	4	,,	10 49	5 24	5 24					0 71 3		0 32 2		9 46 2
,,	312	58	1	2	,,	4 23	4 23	4 23				4 20 4					
,,	315	58	1	4	,,	*1 75	1 75	0 87				0 63 5	1 10 4				
,,	287	51	1	2	,,	5 30	5 30	5 30				2 56 5	..	1 37 5	1 37 4		
,,	291	49	1	2	,,	6 59	6 59	6 59								6 59 3	
,,	294	48	1	2	,,	3 24	3 24	3 24				1 70 5			1 54 4	..	
,,	296	46	2	4	,,	17 62	8 81	8 81				12 07 5			3 00 4		
,,	304	16	1	2	,,	5 45	5 45	5 45				1 38 3			4 07 2		
Mean,		51		3 4	,,	8 40	5 58	5 20				48 3 5	2 15 4	1 6 5	23 0 3	7 8 3	12 6 2
Bulandshahr,	334	39	1	2	,,	3 11	3 11	3 11					1 347 2				
,,	340	34	3	10	,,	10 44	3 45	2 09	2 10	0 70	0 42	6 17 6			0 48 5		
,,	329	30	2	8	,,	3 Wells. 13 02	6 51	3 26				3 56 4	3 65 3	2 25 3			3 56 2
,,	374	30	2	8	,,	28 62	14 31	7 15					10 60 4	1 78 4	11 40 3		
,,	359	27	2	8	,,	19 36	9 68	4 84				5 53 4	1 625 4	2 65 3	0 22 3		1 56 3
,,	369	27	1	4	,,	3 92	3 92	1 96				2 09 4			0 06 3		
,,	389	26	2	8	,,	18 54	9 27	4 63				4 81 4					5 09 3
,,	346	23	3	6	,,	22 01	7 34	7 34	2 20	0 73	0 73	4 50 7			3 84 4		
,,	381	18	1	4	,,	6 69	6 69	3 35				2 56 4	2 12 4				
,,	386	16	1	4	,,	4 35	4 35	2 18				0 88 4					
,,	400	16	1	4	,,	8 11	8 11	4 05	1 12	1 12	0 51	4 12 4		0 96 4	0 13 3		2 70 3
,,	394	15	1	4	,,	11 85	11 85	5 93				5 38 4	0 88 4		1 57 3		3 36 3
,,	353	14	1	4	,,	9 02	9 02	4 51					0 65 4		2 30 3		3 47 3
Mean,	Kharif, Rabi,	24 24		5 7	,,	11 36	7 50	4 18	1 81	0 85	0 55	21 6 4	13 1 4	4 6 3	12 9 3		12 8 3
Meerut,	434	27	2	8	,,	11 20	5 60	2 80				7 22 3					
,,	410	25	4	16	,,	3 Wells. 23 27	5 82	2·91	2 60	0 65	0 33	15 00 1	3 80 3				1 12 3
,,	130	25	3	12	,,	26 05	8 68	4 34				14 43 4		9 00 4	2 62 3		
,,	125	24	2	8	,,	18 03	9 01	4 51	9 75	4 87	2 44	9 25 4					7 20 3

Provinces and Oudh, and the number of waterings required for each class of irrigated crop—1881-83—(Continued)

Rabi.												Kharif					
Safflower	Safflower & Gram.	Safflower & Carrots.	Gram	Carrots.	Peas	Oats	Opium	Tobacco	Potatoes	Garlic	Garden	Sugar.	Cotton.	Indian Corn.	Millet.	Indigo	Remarks.
		0 64									0 02						Area
..	.	6		..							10						Waterings
																	Area
...	..	.	.									.		..	.		Waterings
											0 03						Area
		..						.	..		10				.		Waterings
											0 02						Area
..	.			.	.	.					10		.				Waterings
																	Area
	.	.	.			.	.			...				.			Waterings
																	Area
.	..	.															Waterings
																	Area
..				.					.					.		.	Waterings
		2 55															Area
..	..	5				..			.			.					Waterings
																	Area
.	.															...	Waterings
		4 5									0 05						Per cent area
.	.	5			.						10		.	.			Mean waterings Area 84 87
								0 63			1 13						Area
.		.					.	4			7						Waterings
						0 42					3 37	0 79	1 31				Area
	.	..				6					10	4	1				Waterings
																	Area
												.	.			.	Waterings
			1 34		0 50			3 00									Area
		.	2		2			8									Waterings
			2 56		0 56			3 00			1 65						Area.
			2		2			8			7						Waterings
								1 15			0 62						Area
								8			7		..		.	.	Waterings
5 61											3 03						Area
3		.									7						Waterings
12 00						0 07		1 13			0 47		2 20				Area
3						7		15			10		3			.	Waterings
					1 70						0 31						Area
					2						7						Waterings
											3 47						Area
.		.									7						Waterings
								0 20				2 80	1 12				Area
.		.						8				4	1				Waterings
											0 66						Area
					..						6						Waterings
								0 72			1 88						Area.
.								9			7						Waterings
11 0			2 3		1 8	0 3		6 1			10 5	43 7	56 3				Per cent area
3			2		2	6		9			8	4	2				Mean waterings Area 167 26
									2 70		1 28						Area.
..									10		10			.			Waterings
		0 20			1 25	1 43		0 13			0 34		2 60				Area
		5			2	4		8			6		1				Waterings
																	Area
																	Waterings
			0 70		0 88							7 75	2 00				Area
		.	1		3							8	1				Waterings

District	Number	Depth to water surface.	No of lifts.	No of cattle or men lifting.	Class.	Rabi. Duty per Well.	Rabi. Duty per Lift.	Rabi. Duty per Pair	Kharif Duty per Well.	Kharif Duty per Lift.	Kharif Duty per Pair	Rabi. Wheat	Rabi. Wheat & Barley	Rabi. Wheat & Gram	Rabi. Barley	Rabi. Barley & Gram	Rabi. Barley & Peas
Meerut—(*Contd.*),	406	23	1	4	Kili,	3 89	3 89	1 95				0·66 4	3 00 3				0 23 2
„	419	20	2	8	„	11 34	7 17	3 59	...			11·30 1			0 47 3		
„	439	19	1	4	„	10 42	10·42	5 21				5·20 3			3·91 2		
Mean,		24		6	„	11 91	7 23	3 62	6 17	2·76	1 30	58 0 1	6 3 3	8·9 4	6 9 3		8·0 3
Muzaffarnagar,	444	15	1	8	„				12 40	12 40	3 10						
„	447	12	1	4	„	3 53	3 53	1 77	3 50	3 50	1 75	3 53 4					
Mean, ...	Kharif, Rabi,	13 12	..	6 4	„	3 53	3 53	1 77	7 95	7 95	2 42	100 0 1					
Saharanpur,	451	16	1	4	Lagor,	3 40	3 40	1 70									
„	449	16	1	2	„	2 40	2 40	2 40									
Mean,		17		3	„	2·90	2·90	2 05									
Bijnor,	461	20	1	1	Dhenkli,	1·25	1 25	2·50									
„	463	20	1	1	„	0 25	0·25	0 50									
„	453	17	1	2	Kili,				1 90	1 90	1 90						
„	455	16	1	2	„				1 28	1 28	1 28						
„	465	16	2	16	„				2 Wells 8 70	4 35	1 09						
„	469	16	1	8	„				4 25	4 25	1 06						
„	457	15	1	2	„				1 34	1 34	1 34						
„	459	15	1	2	„				1·25	1·25	1 25						
Mean,		16		3	„				2 40	2 40	1 32						
„		20	1	1	Dhenkli,	0 75	0·75	1 50									
Moradabad,	478	20	1	4	Kili,	0·94	0 94	0 47	0 94	0 94	0 47						
„	484	19	2	2	Dhenkli,				1 00	0 50	1 00						
„	471	18	2	8	Kili,	2 Wells 13·70	6 85	3 42	1 41	0 71	0 36	13 70 1					

Provinces and Oudh, and the number of waterings required for each class of irrigated crop—1881-83—(Continued)

Rabi												Kharif					
Safflower	Safflower & Gram	Safflower & Carrots.	Gram.	Carrots.	Peas.	Oats.	Opium	Tobacco.	Potatoes.	Garlic	Garden	Sugar	Cotton	Indian Corn	Millet.	Indigo.	Remarks.
																	Area
																	Waterings
				0 34		0 23					2 00						Area.
				6		4					6						Waterings
									1 31								Area
									10								Waterings.
		0 2	0 6	0 3	2 0	1 6		0 1	3 7		3 4	62 8	37 2				Per cent area.
		5	1	6	2	4		8	10		7	8	1				Mean waterings. Area 119 55
												12 4					Area.
												5					Waterings
												3 5					Area
												5					Waterings.
												100 0					Per cent area
												5					Mean waterings Area 19·45
											3 40						Area
											10						Waterings.
											2 40						Area
											10						Waterings
											100 0						Per cent area.
											10						Mean waterings Area 5 80
											1 25						Area.
											10						Waterings
											0 25						Area.
											10						Waterings
												1 90					Area
												3					Waterings
												1 28					Area
												3					Waterings
												8 70					Area
												3					Waterings
												4 25					Area
												3					Waterings.
												1 34					Area
												3					Waterings
												1 25					Area
												3					Waterings
											100 0	100 0					Per cent. area
											10	3					Mean watering Area 20 22
								0 94						0 94			Area
								30									Waterings
												1 0					Area.
												4					Waterings
												1 41					Area
												4					Waterings

TABLE B—*Showing the Yearly Area in Acres commanded by Wells in 20 Districts of the North-Western*

District.	Number	Depth to water surface.	No of lifts	No of cattle or men lifting	Class.	Rabi Duty per Well.	Rabi Duty per Lift.	Rabi Duty per Pair	Kharif Duty per Well	Kharif Duty per Lift.	Kharif Duty per Pair	Rabi Wheat.	Wheat & Barley	Wheat & Gram	Barley	Barley & Gram	Barley & Peas.
Moradabad—(*Contd.*)	476	18	1	2	Kili,	1 00	1 00	1 00							..	..	
"	480	10	2	2	Dhenkli,				0 90	0 45	0 90						
Mean,		15		2	"				0 95	0 47	0 95	87 5 1					
"		19		4	Kili,	3 91	2·93	1 63	1 17	0 82	0 42						
Rampur State,	488	21	2	1	Ráti,	0 22	0·22	0 44									
Bareilly,	490	38	3	6	Kili,	3 Wells. 9 40	3 13	3 13									
"	494	38	1	2	"	2 13	2 13	2 13				0 63 2					
"	497	9	2	1	Ráti,	0 50	0 50	1 00									
Mean,		38		2	Kili,	2 90	2 63	2 63	..			5 0 2					
Pillibhit,	501	15	2	3	Dhenkli,				2 80	1 40	1 86						..
Shahjahanpur,	517	33	1	2	Lagor,	2 30	2 30	2 30									
"	514	32	1	2	"	2 28	2 28	2 28							0 56 2		
"	505	30	1	6	Coolie,	4 50	4 50	1 50	2 44	2 44	0 81	4 50 1					
"	508	25	1	6	"				7 56	7 56	2 52	13 3 1					
"	522	24	2	1	Ráti,	1 16	1 16	2 32									
"	526	24	4	2	"	2 32	1 16	2 32									
"	520	13	1	1	Dhenkli,	0 63	0 63	1 26									
Mean,		33		2	Lagor,	2 29	2 29	2·29				67 2 1			2 1 2		
"		37		6	Coolie,	4 50	4 50	1 50	5 00	5 00	1 66						
Unao,	535	38	1	2	Lagor,	1 27	1 27	1 27				1 27 4					
"	537	32	2	4	"	2 94	1 47	1 47				2 94 4					
"	539	32	1	2	"	1 89	1 89	1 89				1 89 4					
"	540	31	1	2	"	3 09	3 09	3 09	..			3 09 4					
"	542	20	1	2	Coolie,	0 70	0 70	0 70				0 70 3					

Provinces and Oudh, and the number of waterings required for each class of irrigated crop—1881-83—(Continued)

Rabi												Kharif					
Safflower	Safflower & Gram.	Safflower & Carrots	Gram	Carrots.	Peas.	Oats.	Opium	Tobacco	Potatoes	Garlic	Garden	Sugar	Cotton	Indian Corn	Millet.	Indigo	Remarks.
								1 00									Area
								30									Waterings
												0 90					Area
												4					Waterings
								12 5				80 0		20 0			Per cent area
								30				4					Mean watering Area 18 95
								0 15			0 07						Area Area 0 22
								28			28						Watering Ráti counted as 1 lift.
								67 0			33 0						Per cent area
								28			28						Mean waterings
								9 40									Area
								20									Waterings
								1 50									Area.
								20									Waterings
											0 50						Area
											10						Waterings
								90 8			4 2						Per cent area
								20			10						Mean watering Area 12 03
												2 80					Area
												2					Waterings Area 2 80
								2 30									Area
								20									Waterings
								1 72									Area
								20									Waterings
												2 44					Area
												2					Waterings
												7 56					Area
												2					Waterings
											1 16						Area
											20						Waterings
											2 32						Area
											20						Waterings
											0 63						Area
											20						Waterings
								15 2			15 5	100 0					Per cent. area
								20			20	2					Mean waterings Area 36 35
																	Area.
																	Waterings
																	Area
																	Waterings
																	Area.
																	Waterings
																	Area
																	Waterings
																	Area.
																	Waterings

TABLE B.—*Showing the Yearly Area in Acres commanded by Wells in 20 Districts of the North-Western*

District.	Number	Depth to water surface	No of lifts	No of cattle or men lifting	Class.	Rabi. Duty per Well	Rabi. Duty per Lift	Rabi. Duty per Pair	Kharif. Duty per Well	Kharif. Duty per Lift	Kharif. Duty per Pair	Rabi. Wheat	Rabi. Wheat & Barley	Rabi. Wheat & Gram	Rabi. Barley	Rabi. Barley & Gram	Rabi. Barley & Peas.
Unao—(*Contd.*),	545	20	1	2	Coolie,	1 33	1 33	1 33				0 28 4					
,,	549	20	1	2	,,	0 50	0 50	0 50				0 30 4					
Mean,		34		2	Lagor,	2 30	1 93	1 93				88 4 4					
,,		20		2	Coolie,	0 84	0 84	0 84									
Lucknow,	572	35	1	2	Lagor,	2 50	2 50	2 50				2 50 3					
,,	578	32	1	4	,,	4 48	1 48	2 24	0 51	0 51	0 26	4 30 3					
,,	574	35	1	4	,,	3 41	3 41	1 71	1 06	1 06	0 53	2 25 3					
,,	555	30	1	6	Coolie,	12 65	12 65	4 22				9 90 2			2 13 2		
,,	563	25	1	7	,,	8 00	8 00	2 29				4 00 2			4 00 2		
,,	559	24	1	4	Lagor,	13 65	13 65	6 82				7 15 2			1 30 2		
,,	566	24	1	4	Coolie,	*1 54	1 54	0 77									
,,	552	22	1	3	Lagor,	3 76	3 76	2 50				3 76 3					
,,	568	17	1	8	Coolie,	16 38	16 38	4 09				9 00 3			5 58 2		
Mean,		30		3 4	Lagor,	6 95	6 95	3 91	0 78	0 78	0 39	64 7 3			19 1 2		
,,		24		7 0	Coolie,	12 34	12 34	3 53									
Hardui,	590	30	1	7	,,	7 00	7 00	2 00				7 00 2					
,,	588	25	1	6	Lagor,	5 30	5 30	1 73	2 00	2 00	0 66	5 30 2					
,,	591	25	1	4	,,	1 40	1 40	0 70									
,,	593	16	2	1	Rati,	2 80	2 80	5 60				2 80 2					
,,	596	16	4	2	,,	1 56	0 78	1 56				1 56 2					
,,	598	16	4	2	,,	1 10	0 55	1 10				1 10 2					
,,	600	16	14	7	,,	7 Wells 7 65	1 24	2 48				7 65 2					
,,	602	10	2	2	Dhenkli	3 50	1 75	3 50				3 50 3					
,,	608	10	4	3	Rati,	4 16	1 38	2 76				4 16 2					
,,	605	9 5	1	1	Dhenkli,	2 38	2 38	4 76							1 25 2		
Mean,		25		5	Lagor,	3 35	3 35	1 21	2 00	2 00	0 66	9 00 2			3 3 2		
,,		14			Rati, Dhenkli	1 78	1 55	3 11									

* These examples are omitted in the calculations for mean areas, &c.

Provinces and Oudh, and the number of waterings required for each class of irrigated crop—1881-83—(Continued)

Rabi												Kharif					
Safflower	Safflower & Gram	Safflower & Carrots.	Gram.	Carrots	Peas.	Oats	Opium.	Tobacco.	Potatoes.	Garlic.	Garden	Sugar	Cotton	Indian Corn	Millet	Indigo	Remarks.
							0 55				0 50						Area.
							10				15						Waterings
							0 20										Area
							10										Waterings
							7 0				4 6						Per cent area
							10				15						Mean waterings Area 11 72
																	Area
																	Waterings
							0 18					0 51					Area.
							6					12					Waterings
							0 46		0 70			1 06					Area
							6		9			8					Waterings
							0 62										Area
							10										Waterings
																	Area
																	Waterings
											5 20						Area
											5						Waterings
							1 54										Area
							5										Waterings
																	Area
																	Waterings
							2 10										Area.
							5										Waterings
							7 3		1 0		7 9	100 0					Per cent area
							6		9		5	10					Mean waterings Area 67 94
																	Area
																	Waterings
												2 00					Area
												8					Waterings
											1 40						Area
											5						Waterings
																	Area
																	Waterings
																	Area
																	Waterings.
																	Area
																	Waterings
																	Area
																	Waterings
																	Area
																	Waterings
																	Area.
																	Waterings
							1 13										Area.
							5										Waterings
							3 2				3 5	100 0					Per cent. area.
							5				5	8					Mean waterings Area 35 85
																	Total Area, 1481 33

Abstract Table B —*Showing Area*

District.	Depth to water surface.	Class	Rabi Duty per Well	Rabi Duty per Lift	Rabi Duty per Pair	Kharif Duty per Well	Kharif Duty per Lift	Kharif Duty per Pair	Rabi Wheat	Rabi Wheat & Barley	Rabi Wheat & Gram	Rabi Barley	Rabi Barley & Gram	Rabi Barley & Peas	Rabi Safflower	Rabi Safflower & Gram	Rabi Safflower & Carrots	Rabi Gram	Rabi Carrots	Rabi Peas
Cawnpore,	34	Lagor,	4 15	2 68	2 57	2 13	1 11	1 35	35 5	38 7				6 3						
Hamirpur,	33	„	4 32	2 61	2 50	2 19	1 64	1 42		3 4		12 0								
Farukhabad,	51	„	4 21	3 15	3 10	1 45	1 15	1 45	18 7	6 4		5 37								
Mainpuri,	24	„	10 98	6 30	3 70				47 5	16 4	4 7	23 8	1 4					2 1	0 8	
Etah,	16	„	5 92	3 20	2 50	1 70	0 57	0 57	56 0	3 0		31 5							4 0	
Saharanpur,	17	„	2 90	2 90	2 05				. .											
Shahjahanpur,	33	„	2 29	2 29	2 29				67 2			2 1								
Unao,	34	„	2 30	1 93	1 93				88 4											
Lucknow,	30	„	6 95	6·95	3 94	0 78	0 78	0 40	64 7			19 1								
Hardui,	25	„	3 35	3 35	1 21	2 00	2 00	0 60	90 0			3 3								
Shahjahanpur,	37	Coolie,	4 50	4 50	1 50	5 00	5 00	1 66												
Unao,	20	„	Omitted 0 84	0 84	0 84															
Lucknow,	24	„	12 34	12 34	3 53															
Hardui,	30	„	7 00	7 00	2 00															
Mainpuri,	17	Kili,	11 58	4 77	3 94	2 31	0 85	0 75												
Aligarh,	24	„	12 92	7 28	4 50	3 02	2 12	1 02	50 3	3 5		24 0		9 6	0 4	0 1	1 6	2 0	2 0	1 4
Muttra,	51	„	8 40	5 58	5 20				48 3	2 15	1 6	23 0	7 6	12 6			4 5			
Bulandshahr,	24	„	11 36	7 50	4 18	1 81	0 85	0 55	24 6	13 1	4 6	12 9		12 8	11 0			2 3		1 8
Meerut,	24	„	11 91	7 23	3 62	6 17	2 76	1 36	58 0	6 3	8 9	6 9		8 0			0 2	0 6	0 3	2 0
Muzaffarnagar,	12	„	3 53	3 53	1 77	7 95	7 95	2 42	100 0											
Bijnor,	16	„				2 40	2 40	1 32												
Moradabad,	19	„	3 91	2 93	1 63	1 17	0 82	0 42	87 5											
Bareilly,	38	„	2 90	2 63	2 63				5 0											
Farukhabad,	16	Dhenkli,	0 60	0 60	1 20															
Bijnor,	20	„	0 75	0 75	1 50															
Moradabad,	15	„	0 95	0 47	0 95															
Pilibhit,	15	„				2 80	1 40	1 86												
Shahjahanpur,	13	„	0 63	0 63	1 26															
Hardui,	10	„	2 94	2 07	4 13				60 0			20 0								
Rampur State,	21	Ráti,	0 22	0 22	0 44															
Bareilly,	9	„	0 50	0 50	1 00															
Shahjahanpur,	24	„	1 74	1 16	2 32															
Hardui,	16	„	1 31	1 34	2 68				100·0											

commanded by Wells, 1881-83

PERCENTAGE.						KHARIF PERCENTAGE				
Oats	Opium.	Tobacco	Potatoes	Garlic.	Garden.	Sugar	Cotton.	Indian Corn	Millet.	Indigo.
..	7 7	4 9	4 0		2 9		81 2			18 8
..	8 8	70 5			5 8	80 2	19 8			.
.	5 8	7 2	7 2	.	1 0			73 8	26 2	
.	0 9	0 4	0 5	..	1·5					
0·5	3 0	.	.			100 0	.			.
.				.	100 0		.			
.		15 2		.	15 0					.
..	7 0				4 6					
	7 3		1 0		7 9	100 0				.
-	3 2				3 5	100 0			..	
.	.					100 0				
							..			
..		..		.			.	.	.	
.	.									
.						100 0			.	..
0 05	0 2	2 7	0 6	0 55	1 00		100 0		.	.
..					0 05				.	.
0 3		6 1		.	10 5	43 7	56 3	.		
1 6		0 1	3 7		3 4	62 8	37 2			.
					.	100 0				
.						100 0				
		12 5			.	100 0		.	..	
		90 8			4 2					
..					100·0					
.	..				100 0		.		.	
			.		100 0		.			.
						100 0				
					100·0					.
.	20·0		...				.		.	
.		67 0			33 0	..	.			
				...	100 0	.	..		.	
.			.		100·0					
			.		.		.			..

Remarks.

The percentage in heavy black type refer merely to the class of lift opposite which they are entered, and are not general percentages of irrigation

Mean Result per pair of Cattle or Men employed

Depth to water surface.	Class.	Labor lifting	ACRES IRRIGATED IN ONE SEASON		
			Rabi	Kharif	Garden
25	Kili,	Cattle,	3 43	1 12	
30	Lagor,		2 58	1 00	.
30		Men,	2 34	1 66	.
15	Dhenkli,	.	*4 13	1 86	1 23
18	Râti,	.	2 68		1 25

* Number of experiments and waterings insufficient.

TABLE C.—*Showing depth of watering given to various crops, and calculated loss from absorption in water-courses*

Observation								Experiment				Calculated Loss						
												Excess.		*Loss*				
District.	Number	Crop	No of waterings required	Soil.	Length of water course.	Watering	Interval.	Cubic feet water lifted in the day	Area irrigated in square feet.	Depth of water on area in feet.	Depth of damp in feet.	Depth.	Length of water-course.	Cubic feet water	Cubic feet per foot of water-course	Area.	Percentage of area lost	Remarks.
CAWNPORE.	2	Wheat,	3	Dumat,	200	1		1,290	4,440	2905								
	20	,,	2	,,	400	1		1,140	1,498	·7610		4817	50	721	14 43	2,583	172 5	No kyaries an new water-cours
	21	,,	3	,,	300	1		2,017	15,765	1279								
	22	,,	3	,,	1,150	1		2,017	1,442	1 398		1 1187	800	1,612	2 015	5,772	358	Water-cours new and no consolidated. First 300 fee same as 21
	Mean	,,		,,	512	1		1,616	5,786	0 2793								Mean, reject ing 20 and 2
	,,	,,	3	,,	350	1	...	1,653	10,102	1636								
		Garden,		,,	100		3	380	4,752	0799								
	533	Tobacco,	10	,,	160	10	12	1,181	8,165	1446	70							
	528	,,	12	,,	270	12	12	1,014	7,550	1343	75							
	Mean	,,		,,	215	11	12	1,097	7,857	1396	72							
HAMIRPUR	34	Barley,	6	Parwa,	150	1		1,139	8,286	1374								
	35	,,	6	,,	130	1		835	6,020	1387	66							
	Mean	,,	6	,,	140	1		987	7,153	1380	66							
	31	Tobacco,	7	,,	200			683	5,705	1197								
	32	,,	10	,,	50	2		2,447	17,020	1437								
	33	,,	10	,,	250	2	20	1,285	7,551	1701		0193	61	143	2 352	951	12 6	
	47	,,	5	,,	256			1,145	6,590	1738		0230	67	151	2·262	1,005	15 2	
	Mean	,,	8	,,	189	2	20	1,390	9,216	1508								
FARUKHABAD	29	Garden,	10	Rakur,	350			375	2,760	1359								2 hours' work.
	63	Barley,	2	Dumat,	510	1		1,184	7,200	1645								
	66	,,	2	,,	440	1		608	5,100	1192								
	69	,,	2	,,	510	1		1,544	9,862	1565								
	72	,,	2	,,	450	1		1,026	4,514	2273								
	Mean	,,	2	,,	477	1		1,090	6,669	1635								
	78	Wheat,	4	,,	560	2		1,089	6,027	1807								
	74	,,	4	,,	160	3		1,270	5,734	2215								
	Mean	,,	4	,,	360	2		1,179	5,880	2005								

TABLE C.—*Showing depth of watering given to various crops, and calculated loss from absorption in water-courses*—(continued)

OBSERVATION								EXPERIMENT				CALCULATED LOSS.						
												Excess		*Loss*				
District.	Number	Crop	No of waterings required	Soil.	Length of water-course.	Watering	Interval.	Cubic feet water lifted in the day	Area irrigated in square feet.	Depth of water on area in feet	Depth of damp in feet.	Depth.	Length of water course.	Cubic feet water	Cubic feet per foot of water course	Area	Percentage of area lost.	Remarks.
FARUKHABAD—(*Continued.*)	86	Garden,	12	Matyar	160			343	3,483	0984								
	87	„	12	„	220			524	3,783	1385		0193	30	72	2 428	611	16 1	
	Mean	„	12	„	190			433	3,633	1192								
	88	Tobacco,	12	Dumat,	400	.	5	1,142	8,286	1378	75							
	90	„	10	„	300			1,684	12,509	1346	75							
	92	„	10	„	250			1,280	8,448	1515	66							
	94	„	10	„	400	...		1,546	8,464	1826	75	0299	50	253	5 060	1,657	19 5	
	Mean	„	10	„	350		5	1,413	9,253	1527	73							
MAINPURI	136	Wheat,	3	„	450	1		1,178	4,890	2409	80							
	110	„	3	„	910	2	30	5,629	23,049	2442	55	0187	184	431	2 343	1,911	8 3	
	123	„	3	„	800	2	30	3,603	15,362	2346	75	0091	74	139	1 889	619	4 0	
	131	„	3	Matyar,	370	2	60	2,511	8,027	3128	1 00							Damp in excess
	133	„	3	Dumat,	680	2	30	1,598	7,509	2128	75							
	138	„	3	„	370	2	37	2,217	13,322	1664	66							
	140	„	3	„	340	2	45	1,934	13,450	1438	50							
	141	„	3	„	240	2	30	1,203	7,240	1662	50							
	147	„	4	„	180	2	30	1,074	5,332	2014	80							
	150	„	3	Matyar,	970	2	60	1,835	10,055	1825	50							Damp deficient
	153	„	3	Dumat,	410	2	30	4,394	19,230	2285	70							
	167	„	4	Mixed,	2,400	2	40	6,697	18,040	3712	1 00	1457	1,674	2,628	1 570	11,650	64 6	
	128	„	3	Dumat,	1,050	3	45	3,388	19,434	1743	75							
	Mean	„	3	„	726	2	39	3,007	13,335	2255	70							
	96	Gujai,	2	Sandy,	600	1		1,475	9,775	1509	50							
	143	„	2	Dumat,	560	1		2,660	11,400	·2333	80							Damp in excess
	Mean	„	2	„	580	1		2,067	10,587	1953	65							
	106	„	3	,	1,060	2	20	4,294	33,107	1297	75							
	113	„	3	„	1,280	2	45	3,518	14,904	2360	66	0733	110	1,092	9 931	6,714	45 0	Interval in excess.
	Mean	„	3	„	1,170	2	32	3,906	24,005	1627	·70							

TABLE C.—*Showing depth of watering given to various crops, and calculated loss from absorption in water-courses*—(continued)

Observation								Experiment				Calculated Loss.						
												Excess.		*Loss.*				
District	Number	Crop.	No. of waterings required	Soil.	Length of water course.	Watering	Interval	Cubic feet water lifted in the day	Area irrigated in square feet.	Depth of water on area in feet.	Depth of damp in feet	Depth.	Length of water-course	Cubic feet water	Cubic feet per foot of water-course	Area.	Percentage of area lost.	Remarks.
MAINPURI—(*Continued*)	100	Guchana,	2	Dumat,	1,120	1		3,718	15,362	2421	75							
	155	„	3	„	1,760	2	45	5,890	24,356	2003	55							
	117	Barley,	2	„	1,710	2	30	6,650	22,000	3023	75	0603	503	1,327	2 637	5,482	24·9	
	120	„	2	„	370	2	45	3,280	14,330	·2289	80							
	160	„	3	„	1,045	2	42	5,586	31,193	1791	55							
	170	„	3	„	810	2	45	1,403	8,252	1700	70							
	173	„	2	Matyar	2,100	2	50	3,815	9,892	3857	80	1437	893	1,422	1 592	5,874	59 4	
	Mean	„	2 to 3	„	1,207	2	43	4,147	17,133	2420	72							
ETAH	166	Carrots,	10	Mixed,	660	2		1,628	11,166	1459	60							
	178	Wheat,	4	Matyar	1,960	2	60	2,974	10,934	2723	55	0450	1,188	491 8	0 414	2,164	19·8	
	180	„	4	„	650	2	45	2,037	10,025	2032	60							
	183	„	4	Dumat,	370	2	60	2,140	6,840	3161	1 00					..		Damp in excess.
	188 189	„	4	„	660	3	30	5,131	33,300	1541	·70							
	192	„	4	„	220	3	30	2,886	5,630	5126	66							
	Mean	„	4	„	772	2 to 3	45	3,034	13,346	2273	·70							
ALIGARH	196	Barley, Oats,	3 6	„ „	780	5	3 30	2,122	13,943	1522	50							
	218	Wheat,	3	„	1,600	2	30	4,374	16,557	·2642	75	0154	532	255	0·479	1,025	6 2	
	221	„	3	„	430	2	30	3,325	18,663	1782	80							
	259	„	3	„	1,650	2	30	13,838	12,758	·2632	75	0144	582	759	1 305	3,054	5 8	
	265	Barley, Wheat,	2 3	„	1,500	2		14,880	54,428	2734	85	0246	432	1063	2 462	4,275	7 8	Damp in excess.
	203	Wheat,	3	„	1,260	3	30	1,691	8,708	·1942	62					...		Damp deficient.
	207	„	4	Matyar	610	3	37	3,638	15,440	2356	75							
	211	„	4	„	980	3	45	3,865	30,540	1266	16		..		.		..	Damp deficient.
	231	„	5	Dumat,	460	3	30	2,375	15,945	1490	70							
	242	Garlic, Wheat,	10 5	„ „	3 225	6 3	15 60	1,982	8,430 6,924	1291	·75 60			.	.		...	Mixed crops.
	268	Wheat,	3	„	1,500	3	60	4,200	13,420	3130	75	0642	432	861	2·00	3,463	25 8	
	269	„	3	„	1,000	3	60	4,853	17,990	2698	80	..	..			..	.	Damp in excess.
	Mean	„	3 to 5	„	983	2 to 3	42	5,370	23,618	1806	·70							

TABLE C—*Showing depth of watering given to various crops, and calculated loss from absorption in water-courses*—(continued)

Observation								Experiment				Calculated Loss						
												Excess		*Loss*				
District.	Number	Crop	No of waterings required.	Soil.	Length of water-course	Watering	Interval	Cubic feet water lifted in the day	Area irrigated in square feet.	Depth of water on area in feet.	Depth of damp in feet.	Depth	Length of water course.	Cubic feet water	Cubic feet per foot of water course.	Area	Percentage of area lost.	Remarks.
ALIGARH—(Continued)	Mean	Wheat,	3 to 5	Dumat,	1,068	2 to 3	38	5,914	23,768	2488	75			..				Omitting 211 and 242
	217	Barley,	2	„	300	2	60	4,033	17,082	2361	80						.	Damp in excess
	257	„	3	„	580	2	30	1,348	4,378	3079	85	1036	140	453	3 24	2,220	50 7	Damp in excess.
	200	„	3	„	420	3	30	1,642	10,600	1549	75							
	234	„ Tobacco,	3 10	„ „	790 320	3 2	30	4,029	15,360 3,836	2099	70 1 10	0056	350	107	0 307	526	2 74	Doubtful mixed crops.
	239	Barley,	4	„	300	3	35	1,270	6,834	1858	80							
	251	Wheat, Barley,	4 3	„ „	460 140	3	60	2,850	5,066 2,640	3690	80 60							Damp in excess
	275	Peas, Barley,	3	„	650	3	60	3,734	26,842	1391	1 00							Mixed crops
	Mean	Barley,	3	„	440	2 to 3	43	2,701	13,220	2043	79							
MUTTRA	255	Kurfa, Garden,	4	„	300	2	6	1,485	12,600	·1179	90							
	279	Carrots,	5	„	600	3	20	2,295	15,207	1509	70							
	291	Barley,	3	Sandy,	520	1		1,862	7,811	2384	90							
	325	„	2	„	550	2	60	2,600	16,524	1574	1 2							
	300	Wheat,	4	Dumat,	1,020	2	67	1,565	6,336	2470	70	0778	496	493	1 00	2,913	46 0	
	312	„	4	Sandy,	120	2	60	1,143	6,504	1761	1 10							Damp in excess.
	307	„	4	Dumat,	500	3	45	1,800	13,024	1382	50							Damp deficient.
	309	„	3	Mixed,	570	3	45	1,247	10,047	1241	66							Damp deficient
	287	„ Guchana,	5 5	Sandy,	180	4	30	1,484	11,037	1345	83							
	315	Wheat, Gujai,	5 4	Dumat,	340	4	30	1,875	12,725	1474	1 00							
	319	Wheat,	5	„	940	4	30	2,490	8,926	2790	80	1098	416	980	2 356	5,792	64 9	
	Mean	„	4 to 5	„	524	2 to 4	44	1,658	9,800	1692	80							
	346	Tobacco,	15	„	790	1		2,550	10,700	2383	66	0297	183	317	1 73	1,523	14 2	
	374	„	8	„	670	1		2,921	11,856	2464	1 00	0374	63	448	7 116	2,149	18 1	Damp in excess.
	400	„	8	Matyar,	360	1		1,738	12,000	1448	1 00							
	Mean	„	10	„	607	1		2,403	11,518	2086	88							
BULANDSHAHR	369	„	8	Dumat,	430	2	5	2,362	20,000	1181	60							
	394	Gujai,	4	Matyar,	750	2	45	3,693	15,000	2462	75							
	381	Garden,	7	Dumat,	300	1		1,871	7,920	2362	1 5							

TABLE C.—*Showing depth of watering given to various crops, and calculated loss from absorption in water-courses*—(continued)

District.	Number	Crop.	No of waterings required	Soil.	Length of water course.	Watering	Interval	Cubic feet water lifted in the day	Area irrigated in square feet.	Depth of water on area in feet.	Depth of damp in feet.	Excess: Depth.	Excess: Length of water course	Loss: Cubic feet water	Loss: Cubic feet per foot of water course	Loss: Area.	Percentage of area lost.	Remarks.
		OBSERVATION						EXPERIMENT				CALCULATED LOSS.						
BULANDSHAHR	386	Garden,	7	Dumat,	230	4	20	3,022	15,000	2015	1 5							
	389	,,	7	,,	500	4	30	4,350	24,160	1800	1 2							
	359	,,	7	,,	810	5	25	3,453	22,680	1523	1 4							
	Mean	,,	7	,,	513	4	25	3,608	20,920	1725	1 4							
MEERUT	430	Barley,	3	Sandy,	1,400	3	60	11,160	44,800	2491	80							
	434	Potatoes,	10	Matyar	640	4	10	3,037	38,577	0787	75							
	434	Wheat,	3	,,	370	2	60	2,710	10,880	2491	75							
	434	,,	3	,,	350	2	60	2,860	14,600	1959	66							
	439	,,	3	,,	3,831	2	60	3,831	11,907	3218	66	0508	233	605	2 597	2,233	18 7	
	441	,,	3	,,	1,020	2	60	4,203	15,557	2702	66							Same water-course as 439, which was still wet.
	406	,,	4	Sandy,	810	3	75	3,100	6,918	4481	75	1771	23	1225	53 27	4,521	65 3	Sandy doubtful.
	412 / 414	,,	4 / 4	,,	923	3	75	9,545	39,374	2424	90							
	425	,,	4	,,	1,020	3	60	6,610	22,000	3004	90	0294	233	646	2 776	2,387	10 8	
	Mean	,,	3 to 4	,,	787	2 to 3	64	4,694	17,320	2710	75							
MUZAFFARNAGAR	444	Sugar,	5	Dumat,	800	1	-	6,111	20,770	2942	1 0							
SAHARANPUR	449	Potatoes,	10	,,	500	3	20	1,510	15,175	0995	80							
	451	Garden,	10	,,	175	3	8	2,047	21,134	0968	80							
BIJNOR	465	Sugar,	3	,,	660	1		3,819	17,578	2173	75							
	465	,,	3	,,	1,380	1		5,015	22,208	2258	66							
	467	,,	3	,,	2,030	1		4,678	13,531	3458	75	0928	673	1,255	1 866	4,963	36 7	
	Mean	,,	3	,,	1,356	1		4,504	17,772	2530	71							
	461	Garden,	10	Matyar	100	*x*		350	6,453	0542	80							
	463	,,	10	,,	60	*x*		114	3,460	0329	60							
	Mean	,,	10	,,	80			232	4,956	04681	70							
MORADABAD	471 / 472	Sugar,	4	Dumat,	800	1		4,162	16,089	2587	75	0030	373	48	129	188	1 1	Damp deficient
	480	,,	4	Sandy,	180	1		1,590	7,800	2039	80							
	484	,,	4	,,	300	1		1,379	4,000	3448	1 2							Damp in excess.
	Mean	,,	4	,,	427	1		2,377	9,296	2557	91							

TABLE C —*Showing depth of watering given to various crops, and calculated loss from absorption in water-courses*—(continued)

Observation								Experiment				Calculated Loss.						Remarks.
												Excess.		*Loss*				
District	Number	Crop	No. of waterings required	Soil	Length of water course	Watering	Interval	Cubic feet water lifted in the day	Area irrigated in square feet.	Depth of water on area in feet.	Depth of damp in feet.	Depth	Length of water-course.	Cubic feet water.	Cubic feet per foot of water-course.	Area.	Percentage of area lost.	
Moradabad	476	Tobacco,	30	Dumat,	270	6	3	985	15,340	0642	80							
	478 {	,,	30	,,	230	6	4	1,010	13,280	0760	70							
		,,	30	,,	250	6	3 5	997	14,310	0696	75							
Rampur.	488	,,	28	Dumat,	100	16	5	276	3,546	0778	66							
	497	Garden,	10	Matyar,	160	1		252	3,000	0840	60							
Bareilly	490	Tobacco,	20	Dumat,	1130	10	7	1,974	14,200	1390	85		.				..	Damp in excess.
	491	,,	20	,,	500	10	7	2,035	14,770	1378	80							
	492	,,	20	,,	470	10	7	870	5,175	1681	75							
	494	,,	20	,,	320	12	7	708	6,080	1190	75							
	Mean	,,	20	,,	580	10 to 12	7	1,397	10,058	1389	79							
Pillibhit	501	Sugar,	2	Sandy,	230	1		423	8,027	0527	70							
	505	,,	2	Dumat,	930	1		1,974	7,200	2742	1 0							
Shahjahanpur.	514	Tobacco,	20	,,	300	10	6	1,984	12,995	1527	90							
	517	,,	20	,,	230	10	10	1,752	10,170	1723	80							
	Mean	,,	20	,,	265	10	8	1,868	11,582	1613	85							
	520	Garden,	20	Matyar,	120		4	360	3,706	0971	60							
	522	,,	20	,,	140			385	2,534	1519	60							
	524	,,	20	,,	150			905	7,590	1192	90							
	Mean	,,	20	,,	137			550	4,610	1193	70							
Lucknow	552	Wheat,	3	Dumat,	400	1		1,197	5,000	2394								
	555	,,	2	Mixed,	1,300	1		1,845	16,000	1153								
	568	,,	3	,,	790	1		4,968	24,000	2070	.	0335	38	804	22 67	4,634	19 3	
	586	,,	3	Dumat,	420	1		468	3,850	1215								
	Mean	,,	3	,,	752	1		2,119	12,212	1735								
	578	,,	3	Matyar,	1,120	2	30	1,136	7,290	1558								
	584	,,	3	Dumat,	580	2		1,037	6,250	1659								
	Mean	,,	3	,,	850	2	30	1,086	6,770	1604								
Hardui	581	Peas,	2	,,	690	2		1,321	13,500	0978								

TABLE C.—*Showing depth of watering given to various crops, and calculated loss from absorption in water-courses*—(continued)

Observation.								Experiment.				Calculated Loss.						
												Excess		*Loss*				
District	Number	Crop.	No of waterings required.	Soil.	Length of water course	Watering	Interval	Cubic feet water lifted in the day	Area irrigated in square feet.	Depth of water on area in feet	Depth of damp in feet.	Depth	Length of water course	Cubic feet water	Cubic feet per foot of water-course	Area.	Percentage of area lost	Remarks.
Hardui.	590	Wheat,	2	Matyar,	505	1		1,470	5 866	2506		0131	193	76	398	323	5 5	
	608	„	2	Dumat,	120	1		540	2,600	2125								
	Mean	„	2	„	312	1		1,005	4,233	·2375								
	588	„	2	Matyar,	510	2	30	1,298	8,425	1538								
	602 } 603 }	Opium,	5	„	130	1		975	4,055	2350								
	605	„	5	„	150	1		424	3,077	1378								
	609	„	5	Dumat,	500	1		498	4,100	1215								
	Mean	„	5	„	260	1		632	3,744	1688								

ABSTRACT TABLE C —*Showing loss by Percolation in water-courses per foot run per day of 9 hours*

Number	Soil	Excess length of water-course.	Loss per foot of water-course.	Time in hours.	Loss reduced to working day	No of lifts.	Percentage of area lost.
33	Parwa, ..	61	2 352	7 75	2 731	1	12 6
47	,, .	67	2 262	7·35	2 770	1	15 2
	Mean, .	64			2 75	1	13 9
87	Matyar, ..	30	2 428	7 4	2 953	1	16 1
439	,, ..	233	2 597	9 75	2 381	1	18 7
590	,, ..	193	0 398	9 12	0 395	1	5 5
178	,, .	1,188	0 414	9 3	0 410	3	19 8
173	,, .	893	1 592	10 3	1 391	4	59 4
	Mean, ..	507	.		1 506	..	20 7
94	Dumat, ..	50	5 060	8·85	5 146	1	19 5
257	,, ..	140	3 24	8 0	3 645	1	50 7
346	,, .	183	1 73	6 7	2 324	1	14 2
467	,, ..	673	1 566	13 0	1 292	1	36 7
22	,, .	800	2 015	8 88	2 042	2	358 0
123	,, ..	74	1 889	10 5	1 620	2	4 0
218	,, ..	532	0 479	9 5	0 475	2	6 2
268	,, ..	432	2 000	9 0	2 000	2	25 8
300	,,	496	1 000	7 7	1 170	2	46 0
310	,, .	416	2 356	10 12	2 095	2	64 9
110	,, .	184	2 343	10 7	2 000	4	8 3
117	,, ..	503	2 637	10 0	2 373	4	24 9
167	Mixed,	1,674	1 570	9 45	1 495	6	64 6
259	Dumat, ..	582	1 305	8 0	1 468	7	5 8
265	,, ..	432	2 462	8 0	2 520	8	7 8
	Mean, ..	478	.	..	2 111		49 1
425	Sandy,	233	2 776	10 5	2 380	2	10 8

Remarks.

Numbers 113, 234, 374, 406, 471, 472, and 568, have been omitted from this Table on account of disturbing influences which are noted in Table C

The loss by percolation is calculated by assuming the mean depth of each class as correct for the length of its corresponding water-courses, the excess depth of watering representing the loss for the extra length of water-course.

The result is curiously uniform, the few inconsistent figures being easily accounted for by the varying age or condition of some water-courses

The mean result gives a loss of 2 372 cubic feet per foot of water-course for a working day of 9 hours, but in calculation it will be safer to deduct 200 feet in every instance from the total length, and to estimate the loss at 2 0 on the balance only, as the first 200 feet of water-course near most wells is thoroughly consolidated

The percentages of loss of area vary according to the crop, and those shown in this Table only represent the loss on the excess length of water-course

E —*Showing Mean Depths of Waterings per Crop, and District, and average interval between each Watering*

District.	WHEAT						GUJAI (WHEAT AND BARLEY).						GUCHANA (WHEAT AND GRAM)					
	Length of water course.	*Depth of Watering*			Depth of damp	Soil	Length of water-course	*Depth of Watering*			Depth of damp	Soil.	Length of water course.	*Depth of Watering.*			Depth of damp	Soil
		First.	Interval	Second, &c				First.	Interval	Second, &c				First.	Interval	Second, &c.		
Cawnpore, ..	512	2793	.	.	.	Dumat												
Hamirpur, ..				..	..	..												
Farukhabad, ..	360		.	2005	.	..												
Mainpuri, ..	450	2409		..	80	.	580	1953		..	65	Sandy, Dumat,	1,120	2421		..	·75	Dumat
„ ..	726	..	39	2255	70	Dumat, Matyar,	1,170	..	32	1627	70	Dumat,	1,760	..	45	2003	55	„
Etah, ..	772	..	45	2273	70	Dumat Matyar												
Aligarh, ..	983	..	42	1806	70	Dumat. Matyar												
Muttra, ..	.	..		..	..													
„ ..	524	..	44	1692	80	Sandy Dumat												
Bulandshahr, .	..	.	..		.	..												
„ ..	..	..		.	..	..	750	..	45	2462	75	Matyar						
Meerut, ..	787		64	2710	0 75	Sandy Matyar												
Muzaffarnagar,	.	..	..		..	..												
Sahâranpur, ..	.	..		..	..	..												
Bijnor, ..	.	.		..	..	..												
Moradabad,	..	.		.	.	..												
Rampur, ..	..	.	.	.	.	..												
Bareilly, ..	.	.	.	.	..	..												
Pilibbit, ..	..	.	.		..	.												
Shahjahanpur,	..	..		.	..													
Lucknow, .	752	1735		..	.	Dumat												
„ .	850	.	30	1604	..	Dumat Matyar												
Hardui, .	312	2375			..	Dumat Matyar												
„	510	..	30	1538	..	Matyar												
Mean,	504	2366	.	.	80	Mixed,	580	1953	.	..	65	Sandy, Dumat,	1,120	2421	.	..	75	Dumat.
„	689	.	42	1985	70	.	960	..	38	2045	72	Dumat, Matyar,	1,760	..	45	2003	55	..

TABLE D.—*Showing periods of Crop growth, mean waterings and intervals*

District	WHEAT: Mean Waterings, No.	WHEAT: " Interval, days,	BARLEY: Mean Waterings, No.,	BARLEY: " Interval, days,	SAFFLOWER: Waterings, No.,	SAFFLOWER: [illegible]rval, days,
[illegible]npore,	3					
[illegible]urpur,			6			
[illegible]ukhabad,	4		2			
[illegible]npuri,	3	39	2	13		
[illegible]h,	4	45	3	30		
[illegible]garh,	4	12	3	43	3	
[illegible]andshahr,	4		3		3	
[illegible]rut,	4	64	3	60	3	
[illegible]zaffarnagar,	4					
[illegible]aranpur,						
[illegible]nor,						
[illegible]radabad,	1					
[illegible]hjahanpur,	1		2			
[illegible]ttra,	5	44	3	60	5	
[illegible]bhit,						
[illegible]no,	4					
[illegible]know,	3	30	2			
[illegible]dui,	2	30	2			